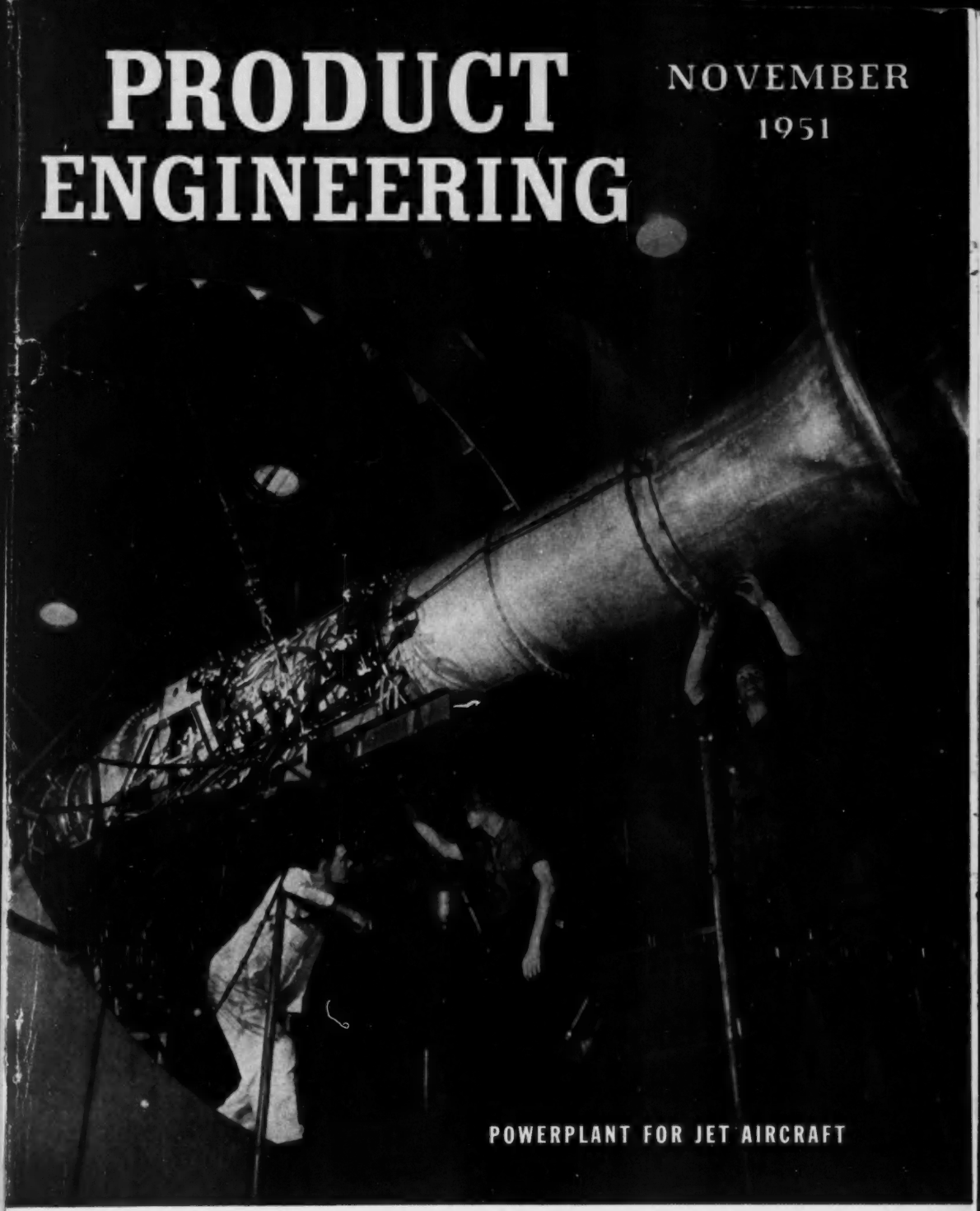
PRODUCT ENGINEERING

NOVEMBER
1951

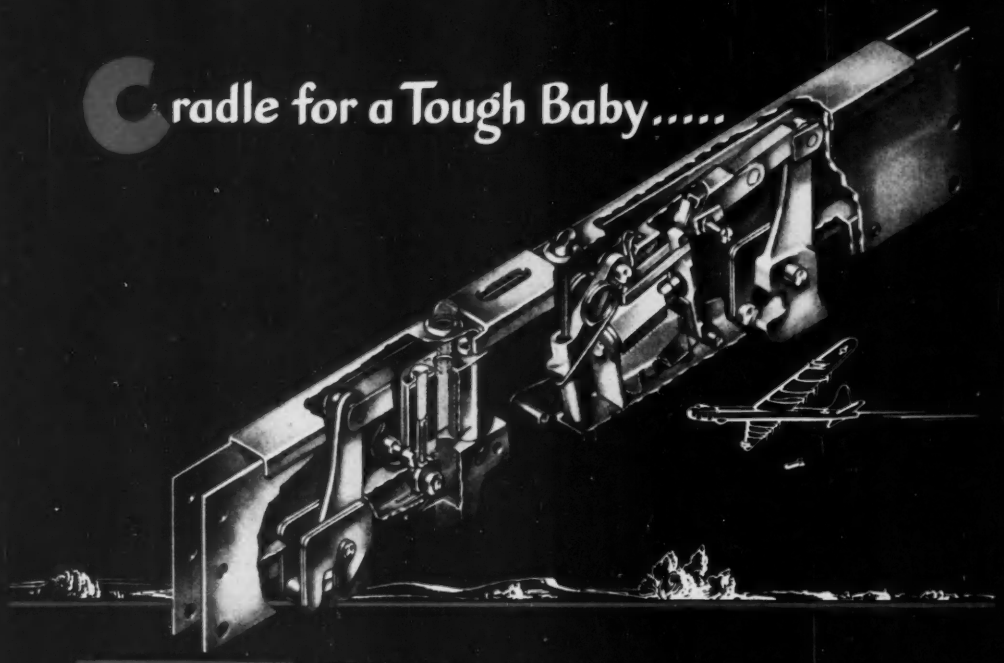


POWERPLANT FOR JET AIRCRAFT

IN THIS ISSUE—High Temperature Ceramic Coatings • Toggle Linkages • Matching Torque Converters to Equipment • Eccentric Beams • Decalcomanias

A McGRAW-HILL PUBLICATION
FIVE DOLLARS A YEAR

Cradle for a Tough Baby.....



SHARON* STAINLESS STRENGTH-WEIGHT RATIO IDEAL FOR HEAVY DUTY BOMB RELEASE

Delivering bombs calls for more than just the airplane. The bombs must be hooked in the bomb bay to stay fixed, yet absorb a minimum of shock, regardless of rough flying. And they must be rigged to allow split-second release for pin-point bombing at high speeds. That's where the modern bomb release comes in. The bomb release is constructed of stainless steel because it must be light, yet have the strength to safely cradle a 2,000 pound bomb. Too, as a precision instrument it must withstand rust and corrosion, another reason designers insist on stainless steel. The manufacture of this and similar all-weather military products demands great amounts of stainless — much of it is being supplied by Sharon Steel Corp.

*Specialists in STAINLESS, ALLOY, COLD ROLLED and COATED Strip Steels.

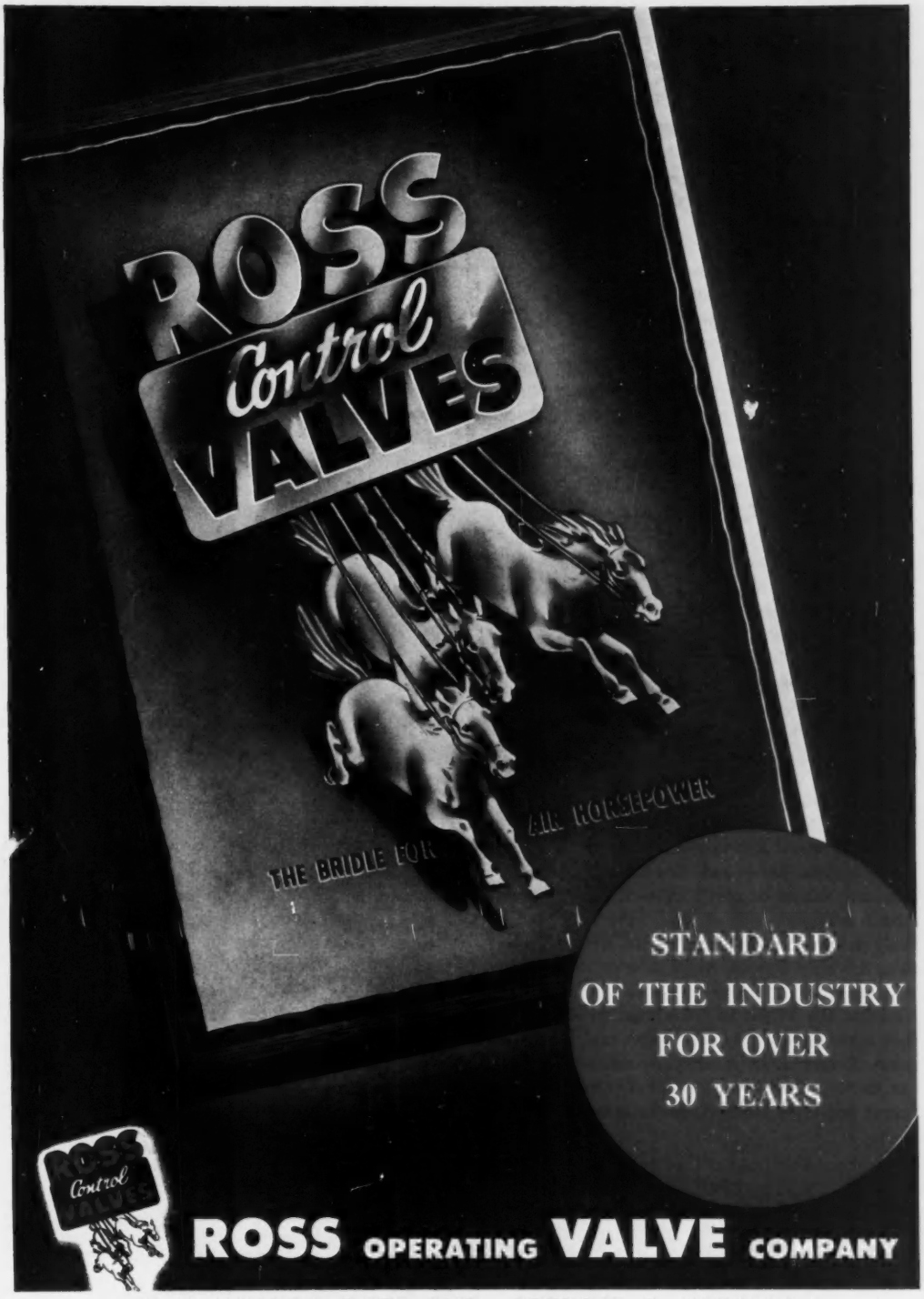
SHARON STEEL CORPORATION

Sharon, Pennsylvania

DISTRICT SALES OFFICES: CHICAGO, ILL., CINCINNATI, O., CLEVELAND, O., DAYTON, O., DETROIT, MICH., INDIANAPOLIS, IND., MILWAUKEE, WIS., NEW YORK, N. Y., PHILADELPHIA, PENNA., ROCHESTER, N. Y., LOS ANGELES, CALIF., SAN FRANCISCO, CALIF., MONTREAL, QUE., TORONTO, ONT.

For information on Titanium Developments contact Mallory-Sharon Titanium Corp., Indianapolis 6

SHARONSTEEL


ROSS
Control
VALVES
THE BRIDLE FOR
ALL HORSEPOWER
STANDARD
OF THE INDUSTRY
FOR OVER
30 YEARS
ROSS OPERATING VALVE COMPANY
120 E. GOLDEN GATE AVE., DETROIT 3, MICHIGAN

BUSINESS IN MOTION

To our Colleagues in American Business . . .

For several years this space has been used to tell how Revere has collaborated with its customers, to mutual benefit. Now we want to talk about the way our customers can help us, again to mutual benefit. The subject is scrap. This is so important that a goodly number of Revere men, salesmen and others, have been assigned to urge customers to ship back to our mills the scrap generated from our mill products, such as sheet and strip, rod and bar, tube, plate, and so on. Probably few people realize it, but the copper and brass industry obtains about 30% of its metal requirements from scrap. In these days when copper is in such short supply, the importance of adequate supplies of scrap is greater than ever. We need scrap, our industry needs scrap, our country needs it promptly.

Scrap comes from many different sources, and in varying amounts. A company making screw-machine products may find that the finished parts weigh only about 50% as much as the original bar or rod. The turnings are valuable, and should be sold back to the mill. Firms who stamp parts out of strip have been materially helped in many cases by the Revere Technical Advisory Service, which delights in working out specifications as to dimensions in order to minimize the weight of trimmings; nevertheless, such manufacturing operations inevitably produce scrap. Revere needs it. Only by obtaining scrap can Revere, along with the other companies in the copper and brass business, do the utmost possible in filling orders. You see, scrap helps us help you.

In seeking copper and brass scrap we cannot appeal to the general public, nor, for that matter, to the small businesses, important though they are, which have only a few hundred pounds or so to dispose of at a time. Scrap in small amounts is taken by dealers, who perform a valuable service in collecting and sorting it, and making it available in large quantities to the mills. Revere, which ships large tonnages of mill products to important manufacturers, seeks from them in return the scrap that is generated, which runs into big figures of segregated or classified scrap, ready to be melted down and processed so that more tons of finished mill products can be provided.

So Revere, in your own interest, urges you to give some extra thought to the matter of scrap. The more you can help us in this respect, the more we can help you. When a Revere salesman calls and inquires about scrap, may we ask you to give him your cooperation? In fact, we would like to say that it would be in your own interest to give special thought at this time to all kinds of scrap. No matter what materials you buy, the chances are that some portions of them, whether trimmings or rejects, do not find their way into your finished products. Let's all see that everything that can be re-used or re-processed is turned back quickly into the appropriate channels and thus returned to our national sources of supply, for the protection of us all.

REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

Executive Offices:

230 Park Avenue, New York 17, N. Y.

SEE "MEET THE PRESS" ON NBC TELEVISION EVERY SUNDAY

VOLUME 22 — PRODUCT ENGINEERING — NUMBER 11

G. F. NORDENHOLT, *Editor*
Assistant to the Editor, Joseph Kerr • *Managing Editor*, V. H. Laughner
Associate Editors, J. D. Cooney, E. S. Cobb • *Assistant Editors*, P. J. Rochford, R. P. Dominic, N. J. Van Ness, C. R. Tobin • *Editorial Assistant*, P. N. Anderson
Consulting Editor, Robert E. Bruckner • *Washington*, George B. Bryant, Jr.
Assistant Publisher, W. E. Kennedy • *Advertising Sales Mgr.*, Stanley J. Alling • *Service Mgr.*, Hugh Britton
Publisher, Albert Hauptli

Foreign News Bureau: London • Paris • Berlin • Moscow • Tokyo • Melbourne • Rio de Janeiro • Buenos Aires • Manila

NOVEMBER 1951

Starting the Graduate Engineer on a Career in Machine Design by W. L. Govan 119
Suggestions for encouraging engineering graduates to begin their careers in the drafting room.

Matching Torque Converters to Prime Movers by W. B. Gibson 123
How to determine converter size and develop engine-converter performance curve.

Decalcomanias for Product Identification by Edwin Drewitz 130
Decals presented as an economic and effective identification form that uses no strategic material.

Product Designs 134
Russian small arms; Electronic scale; Preplasticizer triples capacity of molding press.

Evaluation of Automatic Computing Machines by Franz Alt 146
Principal types of the new group of huge automatic computers are described and compared.

Electronic Instruments for Mechanical Measurements by J. L. Murphy 153
Devices and circuits for sensing, amplifying, and presenting mechanical measurement data.

Designing With Glass Reinforced Plastics 160
A visual presentation of methods of fabrication and recommended design procedures.

A Realistic Approach to the Use of Titanium by H. Hanink 164
Test data just now is revealing some of the pitfalls to avoid when applying titanium.

Toggle Linkage Applications in Different Mechanisms by Thomas P. Goodman 172
Applications illustrate how toggle linkages are effectively used.

Friction Wheel Drives Designed for Maximum Torque by Rudolph Kroener 174
Designs that can be utilized to protect machines from excessive load torques.

High Temperature Ceramic Coatings 177
Coatings that increase the life of parts operating at 1,500 to 2,000 F by as much as 100 percent.

Bending Stresses in Eccentric Curved Beams by Joseph P. Vidosic 180
Recent graphical data from photoelastic tests simplify the calculation of arch and crescent beams.

Investment Casting Alloy Selection and Design by D. V. Ludwig and R. L. Wood 184
Properties of cast alloys plus recommended design practices for improved quality and production.

Mechanical Design Aspects of Electronic Controls by M. Goldstein 191
Discussion of new mechanical design practices that improve the performance of electronic assemblies.

Selection Chart for Investment Casting Alloys by D. V. Ludwig and R. L. Wood 203
Physical properties related to castability of several alloys. Supplements article in this issue.

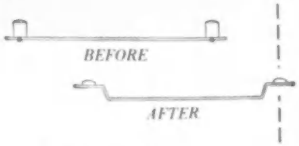
Highlights	5	Technical News	196	Engineering Abstracts	260
Front Cover	9	New Parts and Materials	208	Sans Souci	256
Available Materials	113	New Catalogs and Bulletins	230A	Our Readers Say	271
Editorial	117	Meetings	258	New Books	280

November, 1951 — PRODUCT ENGINEERING — Vol. 22, No. 11

Published monthly by McGraw-Hill Publishing Company, Inc. James H. McGraw (1860-1948), Founder. **Publication Office, 99-129 North Broadway, Albany 1, N. Y.**
Executive, Editorial and Advertising Offices: McGraw-Hill Building, 330 W. 42nd St., New York 18, N. Y. Curtis W. McGraw, President; Willard Chevalier, Executive Vice-President; Joseph A. Gerardi, Vice-President and Treasurer; John J. Cooke, Secretary; Paul Montgomery, Senior Vice-President, Publications Division; Ralph B. Smith, Editorial Director; Nelson Bond, Vice-President and Director of Advertising; J. E. Blackburn, Jr., Vice-President and Director of Circulation.
Subscriptions: Address correspondence to Product Engineering—Subscription Service, 99-129 N. Broadway, Albany 1, N. Y., or 330 W. 42nd St., New York 18, N. Y. **Allow ten days for change of address.**
Please indicate position and company connection on all subscription orders.
Branch Offices: ATLANTA, R. M. Maultsby, 1211 Rhodes-Haverty Bldg.; BOSTON, M. A. Williamson, Jr., 1427 Statler Bldg.; CHICAGO, Anson E. Meanor, 520 N. Michigan Ave.; CLEVELAND, A. F. Tischer, 1510 Hanna Bldg.; DALLAS, J. H. Cash, First National Bank Bldg.; DETROIT, P. G. Weatherby, 856 Penobscot Bldg.; LOS ANGELES, H. L. Keeler, 1111 Wilshire Blvd.; NEW YORK, J. A. McGraw and D. C. McGraw, Jr., 330 W. 42nd St.; PHILADELPHIA, David G. Jones, Architects Bldg.; PITTSBURGH, A. F. Tischer, 738-9 Oliver Bldg.; SAN FRANCISCO, R. E. Dorland, Jr., 68 Post St.; WASHINGTON, National Press Bldg.; LONDON, Aldwych House, Aldwych, W. C. 2, England.
Single copies 50¢. United States and possessions, $5 for one year, $8 for two years, $10 for three years; Canada, $6 for one year, $10 for two years, $12 for three years; Latin American countries, $15 for one year, $25 for two years, $30 for three years; all other countries, $20 for one year, $30 for two years, $40 for three years. Entered as second class matter August 21, 1936, at the Post Office at Albany, N. Y., under act of Mar. 3, 1879. Printed in U. S. A. Copyright 1951 by McGraw-Hill Publishing Co., Inc.—All Rights Reserved.

A McGRAW-HILL PUBLICATION
ABP ABC
Member of Associated Business Publications and Audit Bureau of Circulations

Result Beyond Specification!



MALLORY SILVER CONTACTS

Fine and coin silver, while having desirable properties for many applications, do not provide the physical properties required for some applications. To cover these applications, Mallory has developed a series of silver base alloys. These alloys have such improved characteristics as greater resistance to wear, less sticking or metal transfer, and greater hardness. Mallory is fully qualified to recommend the best contact material for your design. Write today.

Mallory Engineering *Suggests New Contact Assembly . . . Saves Customer Money*

Hundreds of customers are profiting from Mallory contact know-how which simplifies design and production, saves valuable time and money.

A manufacturer of electric toy trains submitted a contact assembly job to Mallory which called for large silver contacts on a flat section of spring steel. Mallory suggested a re-design of the part enabling a great reduction in the size of the silver contact and utilizing a Mallory-developed welding technique to insure maximum mechanical strength. The customer was given improved performance . . . at a substantial saving!

That's result beyond specification!

Mallory contact know-how is at your disposal. What Mallory has done for others can be done for you!

In Canada, made and sold by Johnson Matthey and Mallory, Ltd., 110 Industry St., Toronto 15, Ontario

Electrical Contacts and Contact Assemblies

P. R. MALLORY & CO. Inc.

MALLORY

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

SERVING INDUSTRY WITH

Electromechanical Products
Resistors *Switches*
TV Tuners *Vibrators*

Electrochemical Products
Capacitors *Rectifiers*
Mercury Dry Batteries

Metallurgical Products
Contacts *Special Metals*
Welding Materials

Highlights

When requesting further information from companies and organizations mentioned in the items below, confusion can be avoided by referring to the issue of Product Engineering in which items appear

METALLIC MATERIALS

ALTERNATE ALLOY STEELS have been proposed for cold heading and cold forging wires by the American Iron and Steel Institute. Five alloys, 40B37 modified, 8035, TS8135, 14B35 and 5035 are for components up to 0.5-in. dia; other four, 40B37 (for aircraft use), 80B37, TS8137 and 50B37 are for 0.5 to 0.75-in. diameters.

TIN CANS may have major competition from an aluminum-plastic container recently perfected by Reynolds Metals Co. Discovery is significant because a major use of scarce tin will be converted to more available materials. Plastic-coated aluminum foil is labeled in various colors and rolled on a mandrel. Aluminum top and bottom are then added. Government gets first crack.

AUTOMOTIVE PARTS such as the top rails and brackets used in convertibles, formerly malleable iron castings and steel fabrications, and until recently permanent mold aluminum castings, are now magnesium castings. Alloy being used is Dowmetal C-HTA, which develops a yield strength of 22,000 psi after careful solution heat treatment and precipitation hardening.

HIGH COMPRESSION AUTO ENGINES incorporating mass-produced aluminum blocks and heads are getting serious consideration. Kaiser-Frazer is taking a long look at the latest brazing and die casting techniques with an eye toward realizing large savings in weight, foundry operations and overall production costs.

SMALL AMOUNTS of rare earth metals in hot-dip aluminum baths improve the properties of final coatings. From 0.004 to 0.014 percent beryllium gives a higher metallic luster than does a straight aluminum oxide. Battelle Memorial Institute engineers have also found that cerium reduces surface roughness caused by adhering dross and accumalation of aluminum at base of parts.

NICKEL-FREE ALLOY for high temperature applications is offered by Wilbur B. Driver Co. of Newark, N.J. Intended as a substitute for various nickel-bearing heat resistant materials, iron-chromium-aluminum alloy has maximum operating temperature of 1,750 Centigrade.

"BORON STEELS are now well past the experimental stage", says a spokesman for U.S. Steel. These lean alloys may account for 15 to 20 percent of this country's production by year's end. Best results are obtained through careful temperature control during quenching and tempering.

NONMETALLIC MATERIALS

TEFLON COATED Fiberglas cloth has many uses as elevated-temperature insulation in motors, generators, coil assemblies, heat-sealing equipment and related applications. Sheets 0.003 to 0.010-in. thick meet Class H requirements as electrical insulation, according to an announcement by the Irvington Varnish & Insulator Co., Irvington, New Jersey.

SYNTHETIC GREASE operates satisfactorily on anti-friction bearing surfaces, and in lightly-loaded gears and mechanisms, at -100 F. Engineers at Wright Field Materials Labs say the lubricant, a combination of various oil-base diesters, has reduced high-temperature life.

PHOSPHATIZING COMPOUND, called Rustshield #2, gives steel and iron surfaces a rust resistant, absorbant, non-metallic quality that retains lubricants. Material has proven effective on thrust washers, pump pistons, gears, and valve roller pins, stems and guides.

THE BULKY INSULATION normally used in electricalcomponents can now be replaced by a thermosetting plastic varnish developed by Jack & Heintz Inc., Cleveland. Life of a solenoid used on a jet engine is 100 hr at 500 F., considerably longer at sub-zero temperatures.

(continued on page 7)

IF YOUR PROBLEM IS

BEVEL GEAR OR CURVIC COUPLING DESIGN

MANUFACTURING EQUIPMENT

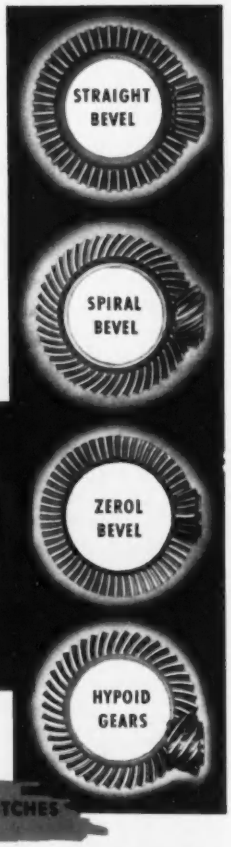
PRODUCTION TIME AND COSTS

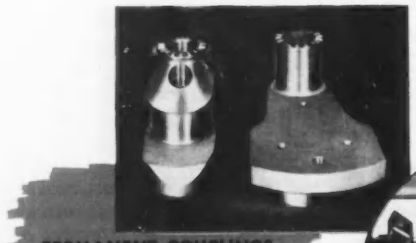
To help you . . .

THE DESIGN ENGINEER should provide us with preliminary layouts or prints of proposed bevel gear designs . . . type of drive, horsepower and speed . . . type of loading (constant, intermittent or shock) . . . type of material . . . driving member and direction of rotation.

THE PRODUCTION ENGINEER should furnish blue prints, material specifications, manufacturing tolerances . . . quantity of gears to be produced . . . number of working hours available for production.

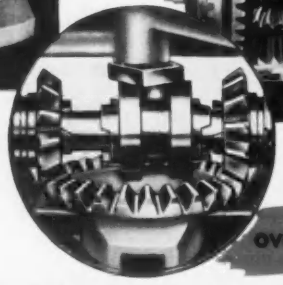
Every day highly skilled engineers within our organization provide the answers to these problems. Backed by the company's 85 years' experience in this field, our complete engineering service is at your disposal, without obligation, to study any bevel gear or Curvic coupling design problem you may have. We will be glad to make our recommendations as to the best design, the proper equipment and the most advantageous methods for reducing production time and costs.





PERMANENT COUPLINGS

SEMI-UNIVERSAL COUPLINGS



OVERLOAD CLUTCHES

BUILDERS OF BEVEL GEAR MACHINERY · FOR OVER EIGHTY-FIVE YEARS · GLEASON

GLEASON WORKS

1000 UNIVERSITY AVENUE · ROCHESTER 3, NEW YORK

VOLATILE POWDER that produces corrosion-inhibiting vapors has been adopted, after expensive testing, by several airlines for protecting the inside and outside surfaces of engine parts. Shell Oil's VPI 260 compound renders the combination of water and oxygen non-corrosive.

ONE COAT of white titanium enamel 0.003 in. thick bonds to non-premium sheet steel so well that sawing, drilling and punching operations can be performed without danger of chipping. Strong Mfg. Co. of Sebring, Ohio, claims this TiLoc coating has other features of standard paints.

MECHANICAL PROPERTIES of General Electric's No. 12650 silicone rubber are reported higher than for existing compositions. Tensile strength is 600 psi; elongation, 240 percent; and the Durometer "A" reading, 50 ± 5. Flexibility is maintained down to -65 Fahrenheit.

SELF-LOCKING BOLT has a head that acts like a flexible diaphragm. Six radial recesses in top of head and a circular recess just above shank permit "rim" of head to flex upward as it comes to bear on a flat surface during tightening. Engineers at the National Screw & Mfg. Co. of Cleveland, fathered the idea.

COMPONENTS

PRECIOUS-METAL CONTACT SLUGS brazed into strip stock at desired locations form a low-cost switch rotor. Engineers at D. E. Makepeace Co. of Attleboro, Mass. say the principle can be used in many types of electrical contact assemblies because slugs can be positioned as needed.

SERVO MOTORS incorporate high-voltage control windings that permit their use without transformers in amplifier circuits. Close-coupled windings are also included for feed-back purposes. Saving of space and weight is primary advantage of these low-inertia motors which are made by Ford Instrument Co. of Long Island City, N. Y.

ANTI-FOULING SPARK PLUG has a pre-combustion chamber which, according to Boeing engineers, contributes appreciably to better performance in airplane engines, cars and outboard motors. Starting, idling and acceleration characteristics are reported superior to those for standard plugs and heat range is wider.

CONDENSING FILTER removes moisture and oil from compressed air lines in two steps. Air passes down through a 24-in. long, 5-1/2-in. dia annulus formed by concentric shells. Expansion of air against large cooling surface causes moisture to condense and fall to bottom of shell. The partially cleaned air then continues up through inner shell where oil is caught in loosely-packed Fiberglas. Air-line Engineering Co. of Cleveland makes this Airlanco filter.

REVERSING DRUM SWITCH made by the Allen-Bradley Co., Milwaukee, is the equivalent of a three-pole double-throw switch. Uses are for across-the-line starting and reversing of a-c and d-c motors rated at two horsepower or less. Applications for the device include drilling machines, milling units and laboratory equipment.

ABSENCE OF MAGNETISM in a bar magnet when heated above its Curie point is the key to the operation of a new fire detecting device. Demagnetized bar actuates a linkage that closes an electrical contact in a warning system. Simmonds Aerocessories, Inc., Tarrytown, N. Y. is the manufacturer.

PROCESSES

TOUGH ALUMINUM ALLOYS used in Lockheed's airplane assemblies are being formed by impact extrusion on punch presses, instead of by conventional machining. Considerable material and production time are saved, and complex parts have higher tensile strength as a result of cold working during forming.

CONVENTIONAL PRESSES are now doubling as the pulling medium for stretch forming aluminum alloy aircraft parts. One system has gripping jaws that can be arranged in a straight or contoured configuration. Technique is in use at the Rohr Aircraft Corp., Chula Vista, Calif., where it has resulted in increased productivity.

RECENT STUDIES made at the National Physical Laboratories in Teddington, England, indicate that by the use of high rolling temperatures and rapid rolling, cast slabs of high strength magnesium alloys containing up to 7.0 percent aluminum can be reduced from 1.5 to 0.3 in. without reheating. In some cases, it is possible to roll the slabs down to 0.1 in. without producing edge defects.

(continued on page 9)

Another new development using

B. F. Goodrich Chemical Company *raw materials*

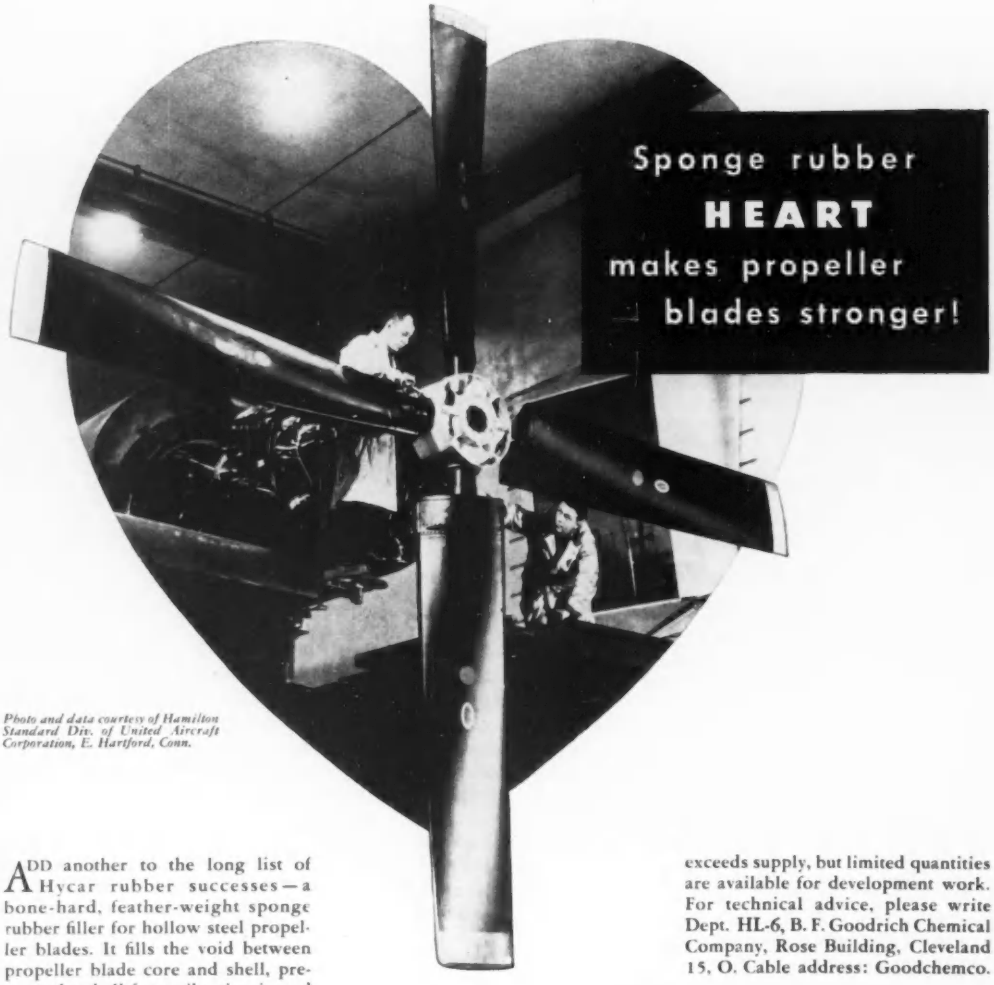


Photo and data courtesy of Hamilton Standard Div. of United Aircraft Corporation, E. Hartford, Conn.

ADD another to the long list of Hycar rubber successes—a bone-hard, feather-weight sponge rubber filler for hollow steel propeller blades. It fills the void between propeller blade core and shell, prevents the shell from vibrating in and out. It also supports the shell against the impact of rocks, ice and other material thrown up by the plane's undercarriage.

To find this filler took several years of search and tests of nearly a thousand rubber compounds. The winner contained phenolic resin, nylon, and an oil-resistant Hycar rubber compound. The presence of Hycar gives added toughness to the phenolic-nylon blend.

Hycar nitrile rubber's versatility helped make this new material possible. For Hycar has high resistance to heat, cold, cooling liquids, gas, weather and wear. It has excellent compression set characteristics, good aging properties and low moisture vapor permeability.

Hycar's advantages make it ideal for many civilian and defense products—in developing entirely new ones. Right now demand for Hycar exceeds supply, but limited quantities are available for development work. For technical advice, please write Dept. HL-6, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, O. Cable address: Goodchemco.

B. F. Goodrich Chemical Company
A Division of The B. F. Goodrich Company

GEON polyvinyl materials • HYCAR American rubber • GOOD-RITE chemicals and plasticizers
HARMON organic colors

Need extreme temperature resistance? Hycar has it—plus abrasion resistance and more advantages.

Hycar
American Rubber

STUD WELDING of aluminum alloys is getting some attention at Cyc-Arc Ltd., London, N1, England. Tests indicate that the stud diameter should not exceed twice the plate thickness. Maximum stud diameter is now about 5/8 in., a limit determined by electrical conditions.

DENSITY CONTROL is a big problem when it comes to making powder metal parts. New method, which utilizes a special hydraulic press, has been developed jointly by the Arthur Colton Co., Detroit, aand Michigan Powdered Metal Prod. Inc. Precision adjustment of upper and lower cylinders permits setting up a definite ratio between the pressures on the top and bottom of briquets.

COLOR MOVIES get the three-dimensional effect through use of an alternate-frame technique perfected at Wright Air Development Center, Dayton, Ohio. One camera, one reel of film, and one projector is used. When the film is shown, viewers wear polarized spectacles that allow the left and the right eye to see alternately every other frame as it is projected on the screen. The result is a synthetic true vision.

TESTING

INTERCHANGEABLE LOAD CELLS of different capacities are the signal devices in a remote recording weighing system made by Streeter-Amet Co., of Chicago. Cell voltage is fed to a balanced bridge circuit containing a calibrated strain gage. Voltage differentials actuate a servo-balancing motor which operates mechanical printing equipment that records data on cards, ledger sheets, tape or other types of permanent record.

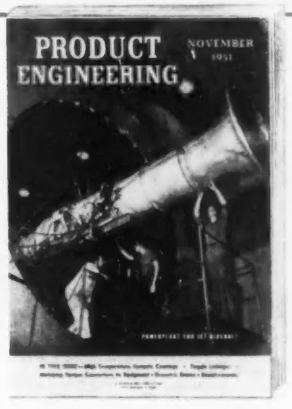
5,000 DATA HOLDERS feature a recorder designed around a slotted drum and associated guides and colored indicators. Lyon-Thompson System, Ltd, Edgware, Middlesex, England call their device the Visi-Control Planning Machine. Data recorded on the drum progresses at predetermined intervals toward a chosen date line.

PHOTO FILM BASES having dimensional stability, optical clarity, low moisture absorption, constancy of composition and good aging qualities in range from -65 to+140 F have been developed at Armour Research Foundation. Material is essentially a cellulosic.

MINIATURIZED DECADE COUNTER comes in two models that cover different ranges. Potter Instrument Co. Great Neck, N.Y., has redesigned the units, one for rates up to 30,000 counts per sec, the other for counts to 130,000 per sec, so that all essential parts are contained in a case measuring 6-1/8 by 6-1/2 by 1-1/8 inches.

WAVE-SHAPER for establishing timing marks in oscillograph studies converts sinusoidal input into a series of unidirectional pulses. Various models of the Labmarker, made by Berkshire Labs of Concord, Mass., produce pips of either positive, negative or both polarities. Peak output pulse is about one-twentieth of the input voltage (36 v max), frequency range is from 25 cycles to one megacycle.

PORTABLE LEAK LOCATOR makes it a simple proposition to spot defects in evacuated assemblies such as vacuum bottles and electron tubes. RCA Victor's Type EMV-7 instrument has high-sensitivity, is fast acting and simple to operate.



THIS MONTH'S COVER

The Wright J-65 is one of the world's most powerful and efficient turbojet engines. Selected by the U. S. Air Force as the powerplant for the new swept-wing Republic F-84F Thunderjet, the J-65 develops 7,220 pounds of thrust and drives the F-84F at speeds in excess of 600 miles per hour. Exact performance figures are restricted.

This month's cover pictures a J-65 installed in one of the jet test cells used by Wright Aeronautical at the company's Wood-Ridge, New Jersey, plant. Many of the extra lines showing in the picture—called "spaghetti" in test engineering slang—are to bring temperature and pressure data to recording instruments in the test cell's control room. The large bell-shaped horn installed in front of the engine's inlet is an air flow measurement nozzle.

Gaskets by Johnson Plastic Corp., Chagrin Falls, Ohio

HERE'S another spot where VINYLITE Plastic outperforms all other older materials—in washing-machine lid seals.

Beaten, battered, constantly exposed to water and detergents, these easily extruded seals of VINYLITE Brand elastomeric materials last a lifetime!

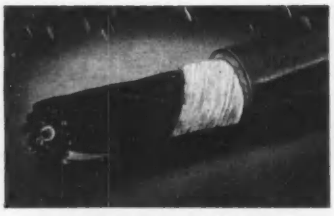
Manufacturers find that their high flexibility simplifies handling, speeds production, saves money. Salespeople make sales points of their color and durability. Housewives welcome their complete freedom from stretching, cracking, swelling, softening. Practically indestructible, they resist detergents, soaps, water, acid and alkali solutions, oils, greases, dirt, mildew, age.

You'll find these materials in the door gaskets of leading refrigerators, in lightweight, quality garden hose, in moisture- and chemical-resistant wire insulation. They're the preferred material of many manufacturers for extruded belts, welting, intravenous tubing, and molded light plugs, distributor cap nipples, vacuum cleaner bumpers, hair curlers, and other products.

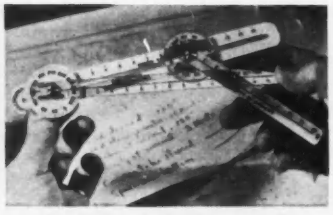
Let them lower your costs, speed assembly, lengthen product life. Write for the free booklet, "VINYLITE Resins and Plastics—Extrusion and Molding Materials." Address Dept. LH-10.

Vinylite
BRAND
PLASTICS
TRADE MARK

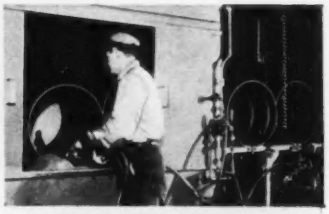
BAKELITE COMPANY
A Division of
Union Carbide and Carbon Corporation
UCC
30 East 42nd Street, New York 17, N. Y.



UTMOST COMPACTNESS for circuitry is achieved in this 30-conductor cable for anything from juke boxes to jet planes. It's jacketed and color-code insulated with strong, flexible, lightweight, oil-, water-, chemical-resistant VINYLITE Brand Plastic. By Lenz Electric Mfg. Co., 1751 No. Western Ave., Chicago 47, Ill.



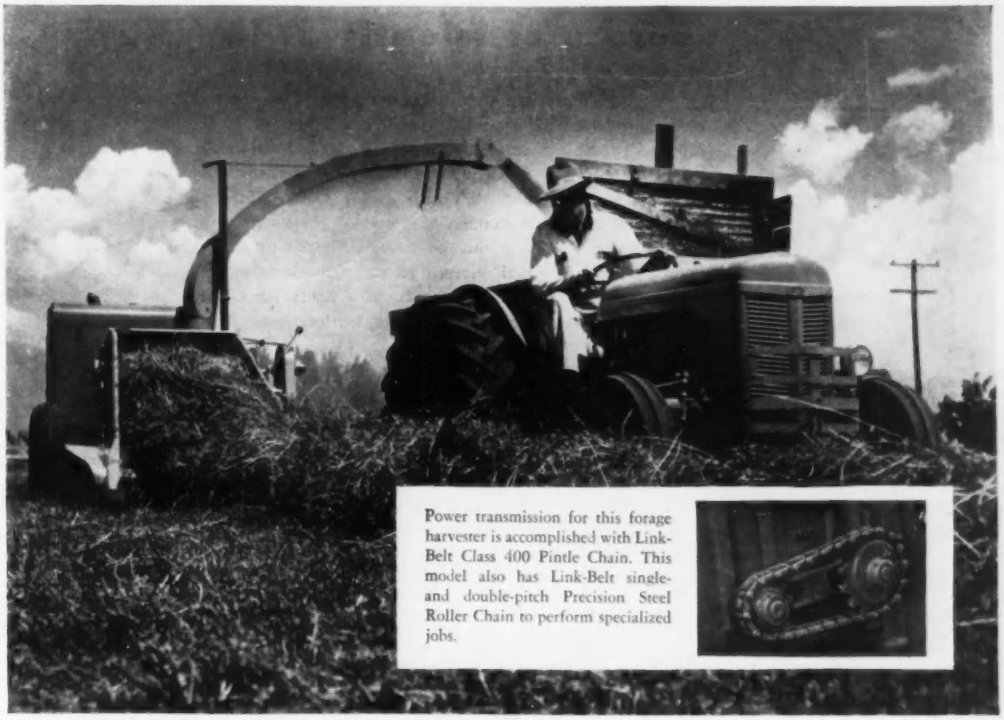
DIMENSIONAL STABILITY despite changes in temperature, humidity, is the feature of VINYLITE Plastic Rigid Sheets from which this water-, oil-, grease-, stain-, and flame-resistant "Correctocourse" instrument is made. Gives boat course, speed, other facts. By Allegheny Plastics, Inc., for Frank G. Darlington, Box 98, Sewickley, Pa.



LASTING PROTECTION. Containers lined with coatings based on VINYLITE Brand Resins withstand oils, greases, alkalies, most strong acids, other chemicals, for years of use and re-use. Odorless, tasteless. Resist impacts, dents. Won't chip, peel, or flake. "Gaco" drum lining by Gates Engineering Co., P.O. Box 1711, Wilmington, Del.

No ONE chain serves every purpose

LINK-BELT makes all types of chains



Power transmission for this forage harvester is accomplished with Link-Belt Class 400 Pintle Chain. This model also has Link-Belt single- and double-pitch Precision Steel Roller Chain to perform specialized jobs.

. . . recommends the right one for your job

Typical chains from the complete Link-Belt line

Steel Link-Belt, similar coupling to cast Ewart Detachable, economical for light drive and conveying service.

Class 400 swivel chain—one of a number of types of Link-Belt chain for carrying cartons, cases, etc.

Class SS bushed roller chain with offset sidebars—for heavy drive service at moderate speeds.

Combination chain, with cast links pin-coupled to steel sidebars, for rugged conveyor and elevator duty.

MORE than strength—more than uniformity—all operating qualities are taken into consideration by Link-Belt engineers when they recommend a chain for one of your machines. From the most complete line of conveying and power transmission chains and sprockets, they can select the *right type* to meet your specific design needs. Large or small, Link-Belt builds them all. And all are built to the highest standards. Exact control of materials and manufacturing processes is your assurance of longer chain life.

LINK-BELT COMPANY: Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa). Offices, Factory Branch Stores and Distributors in Principal Cities. 12,322-B

LINK-BELT

CHAINS AND SPROCKETS

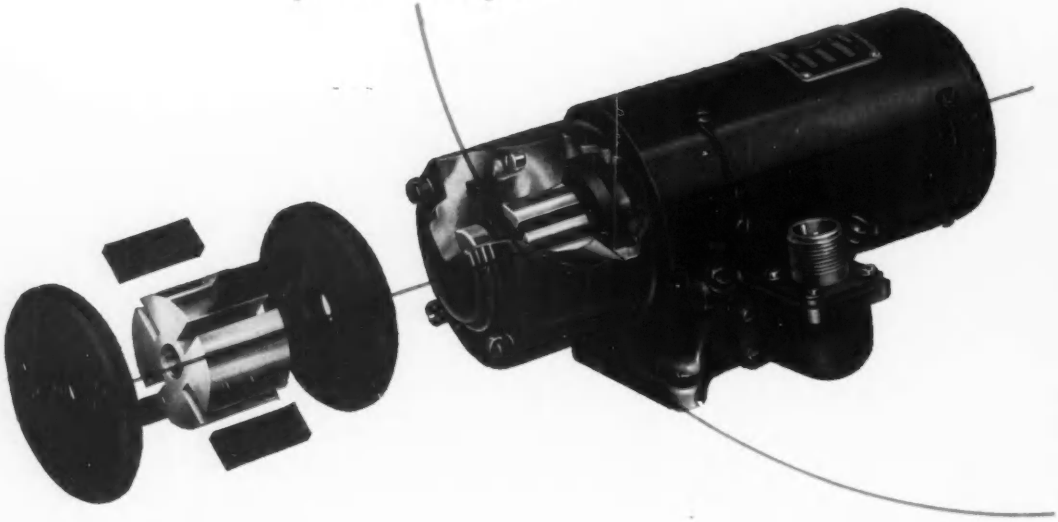
GRAMIX® and GRAPHITAR®

help Lear-Romec air pumps

operate efficiently at 10 miles up!

When a pilot is ten miles high with the temperature down around fifty below, it's mighty important to have radar equipment that he can depend on. It's the job of this little 1/15 hp air compressor made by Romec Division of Lear, Inc., in Elyria, Ohio, to keep radar functioning efficiently. And one of the big reasons the compressor does its job so well is because it's made with GRAPHITAR vanes and end plates and a GRAMIX rotor. At temperatures as low as 67° below zero Fahrenheit and altitudes of 50,000 feet, this little pump delivers a constant supply of oil-free compressed air at "sea-level" pressure for radar and electronic equipment. It will operate continuously at 4600 rpm for 1000 hours. The GRAPHITAR and GRAMIX parts are vital to this efficient performance.

GRAPHITAR is a versatile engineering material for seals, bearings, cylinder liners, pistons and countless other parts. It can be formed into relatively complicated shapes and ground to tolerances as close as .0005". GRAPHITAR is extremely light weight yet mechanically strong and highly resistant to wear, making it ideal for use where weight is a factor. GRAPHITAR will improve your product performance and save critical metals such as steel or aluminum for defense production. It is available in many different grades to meet particular specifications and working conditions.



THE UNITED STATES

PARTS

GRAMIX is die-pressed from powdered metals. It can be oil impregnated during manufacture for self-lubrication, eliminating the need for regular oiling. GRAMIX bearings and specialty parts are strong and tough, too, and they can be precision die-pressed to tolerances within .0005". Because they require little or no machining, GRAMIX parts cost less than similar machined parts. GRAPHITAR and GRAMIX parts can improve the efficiency of your operation in a great many ways. For complete details, write today to —

157

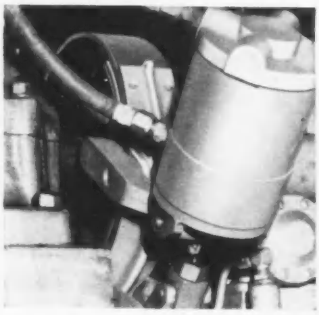
GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW, MICHIGAN

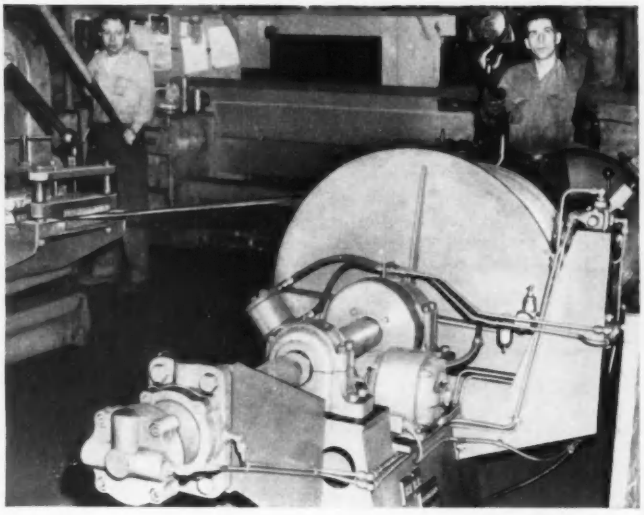
Effective Control Without Overheating!

TDA BRAKES

SOLVED THIS PROBLEM FOR GOOD!



Too much heat—not enough control! That was the problem of the Brainard Steel Company until they equipped their "Pay-out Reel" with a TDA Duo-Grip Brake! This machine serves the purpose of holding a coil of steel which is drawn into a cold rolling mill and then re-coiled. The brake is used to check the unwinding coil and, therefore, is constantly engaged and constantly generating heat. The open brake drum area of the TDA Brake allows for rapid heat dissipation—adding to braking efficiency and eliminating a possible fire hazard! Moreover, this sturdy brake has proved to be simpler to maintain.



WHATEVER *YOUR* BRAKING PROBLEM— TAKE IT TO TDA BRAKE DIVISION!

Controlled rotation is often the key to high production output! Dependable, responsive brakes eliminate breakdowns—keep machines humming at a steady clip! Recognizing this important fact, alert manufacturers are standardizing on smooth, efficient TDA Brakes! They're taking full advantage of the more than 40 years of experience offered by TDA Brake Division—experience concentrated in a highly competent staff of brake technicians. Let TDA Brake Division put its forces to work in developing the specific type of brake you need to meet your exact requirements! Mail the coupon below for more information on how TDA Brakes can be applied to your product.

Here Are A Few Of The Many Products Which Can Be Equipped With TDA Brakes

Centrifuges • Compressors • Conveyors • Cranes Cream Separators • Diesel hook-ups • Dry cleaning machinery • Extractors • Hoists • Industrial electric trucks • Lathes (automatic) • Looms (textile) • Lumber mill machinery • Machine tools • Materials handling equipment • Motors • Packaging machinery • Paint mixers • Press brakes • Printing presses • Rolling mills • Shears • Warpers (textile) • Welding positioners • Winches • Automotive • Farm equipment Earth moving equipment • Construction equipment Public transportation.

IF IT ROTATES WE CAN BRAKE IT

TDA BRAKE DIVISION—DEPT. A-8
ASHTABULA, OHIO

Please mail brake information on these applications.

NAME _____

COMPANY _____

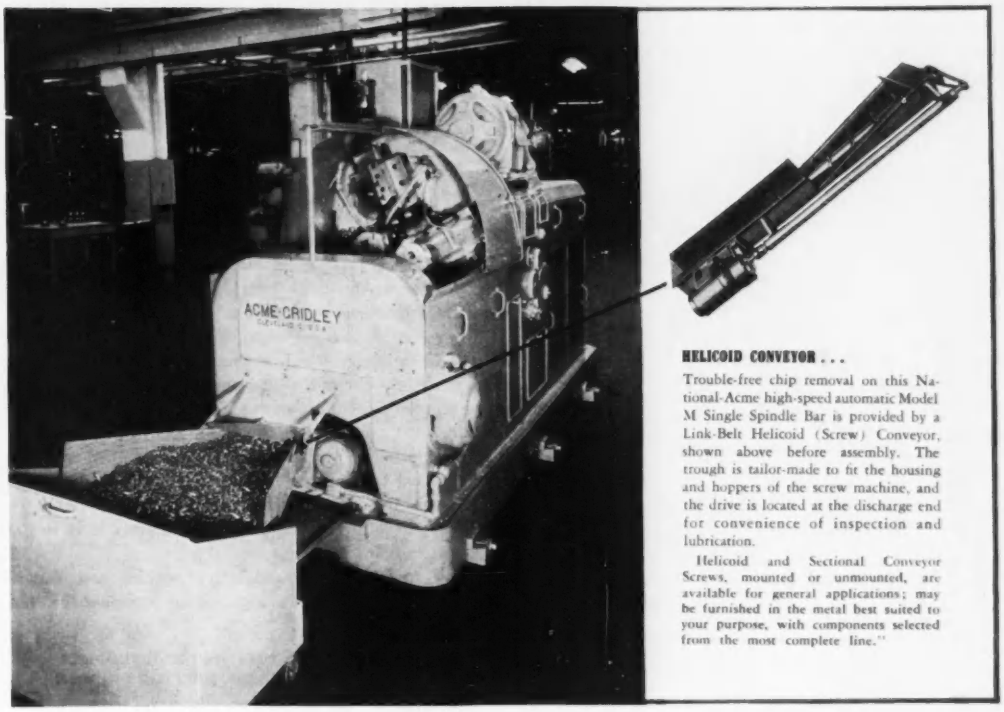
ADDRESS _____

CITY _____ **STATE** _____

TIMKEN Detroit BRAKES
TDA BRAKE DIVISION
THE TIMKEN-DETROIT AXLE COMPANY
ASHTABULA, OHIO.
The Accepted TDA Standard
TRADE MARK REGISTERED

All Screw conveyors are not the same

LINK-BELT offers you the widest range to match your design needs



HELICOID CONVEYOR . . .

Trouble-free chip removal on this National-Acme high-speed automatic Model M Single Spindle Bar is provided by a Link-Belt Helicoid (Screw) Conveyor, shown above before assembly. The trough is tailor-made to fit the housing and hoppers of the screw machine, and the drive is located at the discharge end for convenience of inspection and lubrication.

Helicoid and Sectional Conveyor Screws, mounted or unmounted, are available for general applications; may be furnished in the metal best suited to your purpose, with components selected from the most complete line.

MORE than capacity . . . more than length . . . are considered by Link-Belt engineers when they recommend screw conveyor for your machines. Abrasiveness, moisture content, size of feed, corrosiveness and many other factors are vitally important.

Remember, Link-Belt is the nation's top producer of materials handling and power transmission equipment . . . another reason why Link-Belt Screw Conveyors are simple, compact, have few wearing parts, greater dependability. Then too . . . They're accurately made to insure easy assembly and smooth operation.

Link-Belt Screw Conveyors are made in both continuous and sectional flight types — mounted and unmounted. Our engineers will be glad to give you the complete story.

LINK-BELT

SCREW CONVEYORS

LINK-BELT COMPANY: Chicago 8, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa). Offices in principal cities. 11.310

Worried about the Wire situation?

● Each day, the mobilization program brings new and tougher problems for users of wire.

So *our* biggest job now, as we see it, is to help you solve these problems. And as the world's largest manufacturer of steel wire, we believe we can do it.

On our staff, we've got some of the best metallurgists in the world. They've worked on thousands of wire application problems. And—here's the best part—a problem that is new to you may be old stuff to our engineers. Maybe you're using a wire that's unsuitable for the job it has to do. No matter what your problem, our metallurgists are qualified to recommend the best type of wire for the application, and they are always ready to cooperate with you.

Anyway, if you're having trouble, it doesn't hurt to find out if we can help you.

This offer of free advice and help is nothing new. But we think you'll agree that this is a good time to repeat the offer.

AMERICAN STEEL & WIRE COMPANY, GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA STEEL COMPANY, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
TENNESSEE COAL, IRON & RAILROAD COMPANY, BIRMINGHAM
SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

AMERICAN MANUFACTURERS WIRE

AMERFINE—*High-quality fine wire.*

AMERSPRING—*music steel spring wire.*

AMERLOY—*alloy heading wire.*

AMERTEMP—*heavy-duty oil-tempered wire.*

AMERHEAD—*uniform heading wire.*

AMERSTITCH—*extra-tough metal stitching wire.*

AMERICAN
MANUFACTURERS WIRE

USS

UNITED STATES STEEL

TRADE MARK

REG. U. S. PAT. OFF.

Presenting

a NEW MARK of Long-Established Quality

Since 1878 and the earliest bicycle cyclometer . . . to the present day when counters are built into everything from hay-balers and textile looms to jet planes and gasoline pumps . . . Veeder-Root has been "the name that counts."

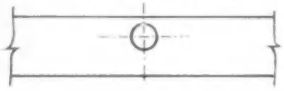
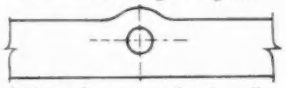
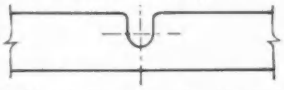
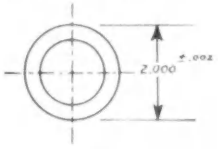
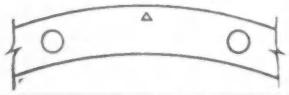
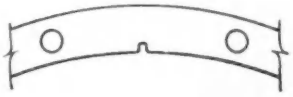
Today, Veeder-Root is the world's largest manufacturer of counting and computing devices for mechanical, electrical, and manual operation. And as a symbol of "the name that counts," this trademark has been developed as a hallmark of old-fashioned quality and modern design *in everything that counts.*

So when you buy counters, look for this mark, and remember: V-R stands for Veeder-Root . . . and also for *"Value Received."*

VEEDER-ROOT INCORPORATED
"The Name That Counts"
HARTFORD 2, CONN. • GREENVILLE, S. C.
Montreal, Canada . Dundee, Scotland
Offices and agents in principal cities

Veeder-Root COUNTERS *"Count Everything on Earth"*

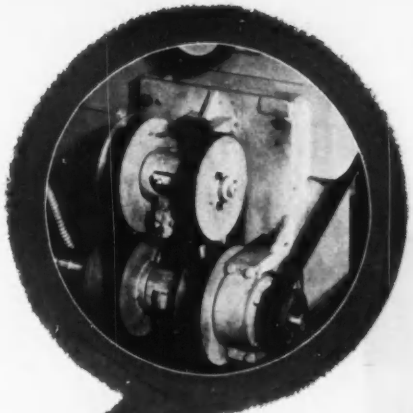
How to remedy common errors in gasket design

The fault	The reason	The remedy
Bolt holes too close to edge. 	Gaskets so designed are expensive to make as well as expensive to use. They break easily during stripping and center picking and are easily damaged in transit. Often such gaskets also demand careful handling during assembly.	a. An "ear"; strengthens gasket.  b. A notch; removes fragile wall. 
Metal-working tolerances applied to gasket thickness, diameter, length, width, etc. 	Close tolerances involve special dies, extra manufacturing operations, and special sorting and inspection. This delays deliveries and increases costs.	Specify realistic tolerances. In most cases, a *resilient* gasket is entirely satisfactory if held no closer than ± .010", even on metal parts that must be held to ± .002". Try standard or commercial tolerances before concluding that special accuracy is necessary.
Very small bolt holes . . . or small non-circular openings. 	Centers from such holes probably require hand-picking. Because small holes are easy to miss, extra inspection must be employed. Naturally, this slows down gasket production and increases gasket costs.	Avoid hole sizes under 3/32" diameter. If hole is for indexing or positioning, it may be possible to change to a small notch. 

You'll find other helpful information on the design and use of gaskets in "Armstrong's Gasket Materials." This 24-page manual discusses subjects such as designing gaskets to reduce cost . . . designing flanges for efficient sealing . . . the effect of surface condition on gaskets, and many others.

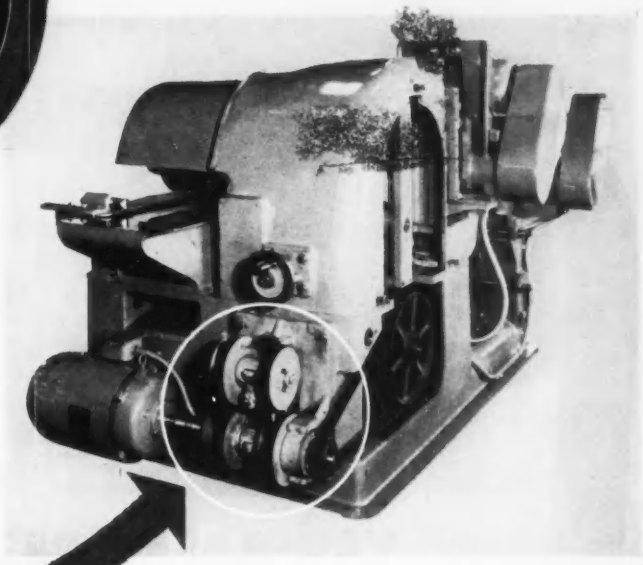
You'll find, too, up-to-date information on Armstrong's various sealing and friction materials. Included are government and SAE-ASTM specifications. See this manual in Sweet's file for product designers. For a personal copy, write Armstrong Cork Co., Gaskets and Packings Dept., 5111 Arch Street, Lancaster, Pennsylvania.

Armstrong's *Gasket Materials*



Get Wider Speed Variation in Narrower Space

. . . with TANDEM BELT DESIGN of this new variable speed drive



The broadest possible range of instantaneous, stepless variations—far greater than those obtainable with the single belt used in conventional variable speed drives—is yours with the new Worthington ALLSPEED DRIVE.

Its exclusive two-belt tandem design also permits the use of a *narrower* belt with consequent less wear from flexing and compression—all of which adds up to longer life.

Other plus values: Easy belt replacement—no need to dismantle the unit. Automatic positive belt tensioning. All wearing parts bronze-bushed. All ball bearings shielded and life-lubricated. In-line input and output shafts. Can be run in either direction.

Send coupon for Worthington Allspeed Drive bulletins AS-1600-B3 and AS-1600-B4. Worthington Pump and Machinery Corporation, Worthington Allspeed Drive Division, Holyoke, Massachusetts.

MODELS TO FIT ANY DESIGN

Six sizes from 1-15 hp; up to 16-1 range of variation.

Covered or skeleton models—or supplied less any parts, such as without shifting parts for attachment to your shifting mechanism.

With or without built-in motor—standard NEMA Frame 1750 rpm motor.

Upright or horizontal frame.

Extended control yoke available.

WORTHINGTON

THE GOOD RIGHT HAND OF INDUSTRY

POWER TRANSMISSION: sheaves, V-belts, variable speed drives

PUMPS: centrifugal, power, rotary, steam

AIR COMPRESSORS: water-cooled, air-cooled

AS.1.4

Worthington Pump and Machinery Corporation
Worthington Allspeed Drive Division
Holyoke, Massachusetts

Please send bulletins AS-1600-B3 and AS-1600-B4 on Worthington Allspeed Drive.

Name_____

Company_____

Address_____

handle more shapes— sizes and materials on one machine!

—give the machines you build <u>extra</u> "Change-over Capacity"—<u>extra</u> *profit* capacity with—

REEVES

VARIABLE-SPEED DRIVES

With so many plants now converting to defense production, your customers are in critical need of machines that can handle the greatest possible variety of work without costly delays in changing over from one job to another.

By making REEVES Variable-Speed Drives standard equipment, you can give your customers machines that handle a far wider range of shapes, sizes, and materials—merely by turning a handwheel, touching a button, or automatically. And, *always,* for each different shape, size or material, the REEVES Drive will deliver *exactly* the right speed to assure the maximum rate of production.

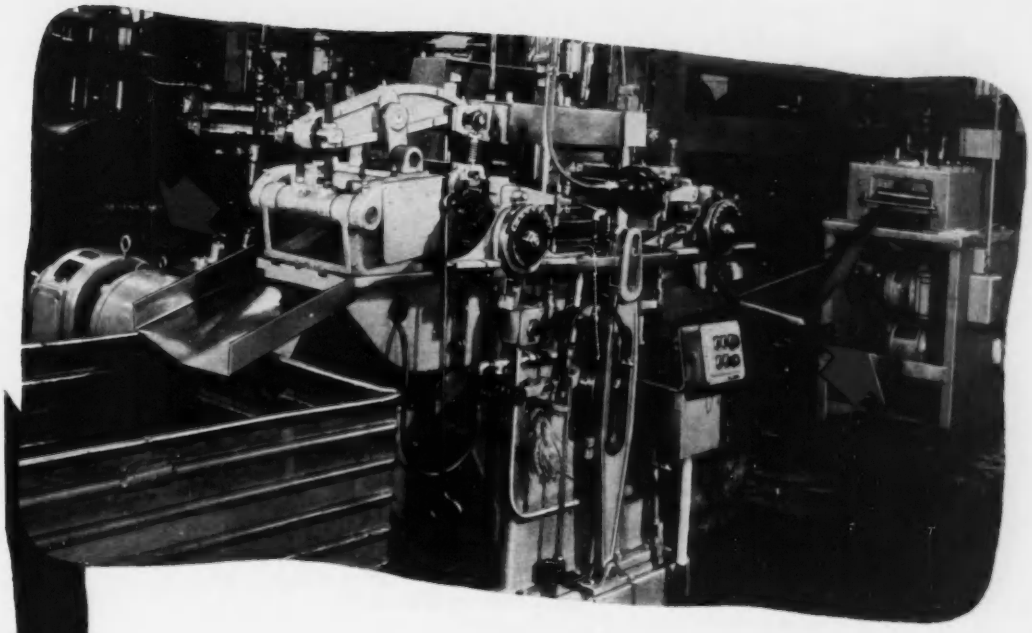
Take the first step today in this vital improvement of your product. Write for the name of the REEVES Speed Control Engineer in your locality. He'll give you full details on *America's only complete line of variable speed drives . . .* the reliable REEVES line . . . competent counsel on how to adapt REEVES to your particular needs. No obligation, of course.

REEVES PULLEY COMPANY · COLUMBUS, INDIANA

Recognized leader in the specialized field of variable speed control

Ask for complete information, including engineering drawings and technical data, on the full line of REEVES Variable-Speed Drives and Controls. Send for Catalog No. K75-3N.

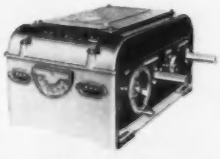
accurate · variable
REEVES *Speed Control*



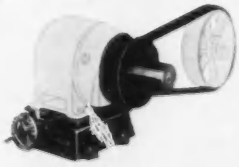
Example: Here's how National Cash Register uses REEVES-equipped machines to handle more shapes, sizes and materials

REEVES Variable-Speed Drives are standard equipment on the three sizes of Henry & Wright Dieing Machines, manufactured by Henry & Wright, Hartford, Conn., which are used by The National Cash Register Company, Dayton, Ohio. These machines produce 310 different parts at rates varying from 80 strokes per minute for larger parts or heavier stock to 400 strokes per minute for smaller parts or lighter stock. Machine speeds must be changed over that wide range with the least possible delay. In above installation, a REEVES Vari-Speed Motodrive (arrow at right) accurately controls the rate of feed into the dieing machine. Another REEVES Motodrive (arrow at left) varies the machine's strokes per minute, to assure maximum production of each different part.

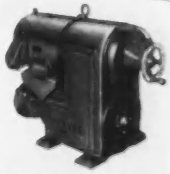
Make REEVES standard equipment on your machines . . . choose from the complete line built around these three REEVES basic units



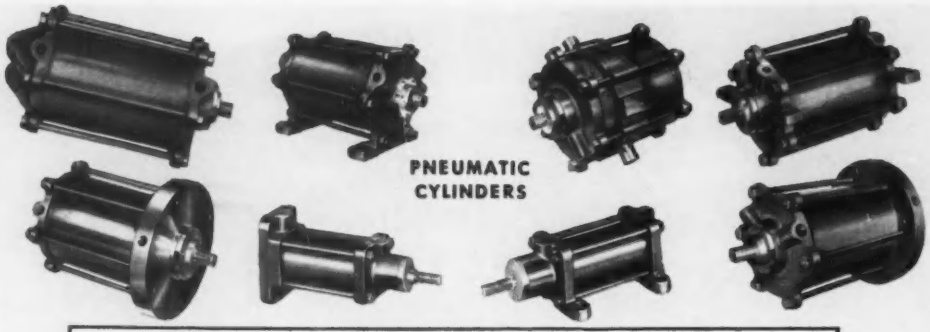
VARIABLE SPEED TRANSMISSION provides infinite, accurate, stepless speed adjustability over a wide range—as high as 16 to 1. Sizes to 87 hp.



VARI-SPEED MOTOR PULLEY converts any standard, constant-speed motor to a variable speed drive. Speed variations to 4 to 1. Sizes to 10 hp.



VARI-SPEED MOTODRIVE ® combines motor, speed-changing mechanism and gear reducer in one unit. Speed variations as great as 10 to 1. Sizes to 25 hp.



PNEUMATIC CYLINDERS

Q: Joe, do you think you can buy a cylinder to do this job? It looks plenty special to me!

A: Absolutely, Boss! Hannifin has more than 65 different mounting combinations in hydraulic cylinders, alone. And, if it has to be a special cylinder, Hannifin can build that, too.

Hannifin is *the* authoritative source for the broadest range of hydraulic and pneumatic cylinders—backed by an experienced corps of engineers, sold by a large force of factory-trained field engineers. Illustrated here are only a few of the many standard Hannifin hydraulic and air cylinders. Hannifin Corporation, 1125 South Kilbourn Avenue, Chicago 24, Illinois.

Complete hydraulic cylinder catalog, illustrating design features, styles, dimensions. Also bore tables, engineering data and formulae.

Complete illustrated pneumatic cylinder catalog giving design and construction features, bore tables, mounting styles and other information.

HYDRAULIC CYLINDERS

YOU CAN BE *SURE*, IF YOU—do *ALL* you CAN do... with

HANNIFIN

Air and Hydraulic Cylinders • Hydraulic Power Units • Pneumatic and Hydraulic Presses • Hydraulic Riveters • Air Control Valves

Design Dept.:

Let's find out what *else* is new in plastics.

J.B.

a "new-idea" in plastics

"Only a plastic, like Monsanto's Lustrex styrene, could have made this popular-priced file possible"—says Jack Stahl, Secretary, Rona Plastics, Inc. KIN-DEX rotary file is molded by Rona for Kinetic Novelty Co., Inc., both of New York City.

The case for plastics is clearly on file—in the new Kin-Dex rotary file for home and office. Light in weight, durable, attractive—Monsanto's Lustrex styrene plastic enables Kinetic to put a finer product on the market . . . at a saving to the buyer.

With swift new developments in the plastics field, *dozens* of manufacturers are taking a new look at these basic engineering materials—to make their new products . . . and old ones . . . BETTER, FASTER, AT LOWER COST.

For your own product . . . or new idea . . . investigate Monsanto's big *family* of plastics. And, for expert materials engineering assistance, send your materials or design problem to The Monsanto Technical Council—a board of ten plastics technicians whose experience and knowledge blankets the plastics industry. Probably they can help you make an old product better . . . bring a new product to life. Write: MONSANTO CHEMICAL COMPANY, Plastics Division, Room 2111, Springfield 2, Mass. Lustrex: Reg. U. S. Pat. Off.

Also—send for your free copy of Monsanto's plastic-idea booklet, "Idea Generators."

Look at this—better product... and lower cost.

Send to Monsanto today. Get all the information you can.

MONSANTO
CHEMICALS—PLASTICS

SERVING INDUSTRY
. . . WHICH SERVES MANKIND

MONSANTO CHEMICAL COMPANY, Plastics Division,
Room 2111, Springfield 2, Mass.

- ☐ Please send me information on the big Monsanto family of plastics.
- ☐ Please send me your booklet, "Idea Generators."
- ☐ Please send information about The Monsanto Technical Council and how they can help us.

Name & Title

Company

Address

City, Zone, State

DO NOT LUBRICATE
Simplifies installation in cramped quarters. The smaller size of Life-Line motors aided designers of machines and equipment . . . required less space. Pre-lubricated bearings eliminated extra fittings and piping.
FOR THE BEST DESIGN
USE Life-Line
WESTINGHOUSE
RESET
Compact design minimizes required space. Life-Line starters installed in control cabinet on a precision lathe. Front removable parts and straight-through wiring saved additional space . . . facilitated general servicing.

Cramped ?

Here's how to stretch space

Life-Line motors and Life-Linestarters® are space stretchers. The reason? "Compactness." They are smaller, lighter than most conventional types . . . often can be installed in close quarters where others cannot be accommodated.

Take the case of this grinder manufacturer, for example: The motor is mounted under the bed inside the housing. Space is at a premium. With ordinary conventional motors, it was necessary to grind part of the motor housing away so that motors could be squeezed into the available space. Life-Lines (as much as ⅓ smaller for the same frame size)—fit with room to spare.

Further, the pre-lubricated, sealed bearings eliminate the need for bringing grease fittings to the outside of the housing. This means an additional saving of several dollars per machine—in materials and labor.

Life-Linestarters match the motors for compactness. Because all parts can be removed straight from the front, there is no need to allow extra workroom for servicing. Further, straight-through wiring means simplified wiring, shorter leads, less space. You can have two electrical interlocks without increasing Life-Linestarter width. After that, two more may be added with little additional space.

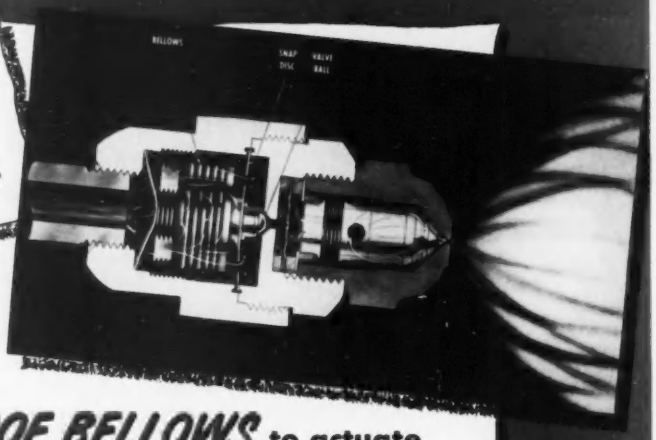
These space savings result in smaller cavities . . . and more compact cabinets . . . reducing your costs. NEMA mountings are standard for the complete line.

More data? Complete information, on sizes and mounting dimensions, is available from your nearby Westinghouse representative. Ask him for copies of "Life-Line Motor Book", B-3842 and "Tomorrow's Starter Today", B-4677 or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21625

YOU CAN BE SURE.. IF IT'S
Westinghouse

Life-Line
MOTORS and CONTROLS

In Minneapolis-Honeywell's new Dribble-Proof Burner Valve, oil is held back until pressure on the Clifford Bellows indicates proper atomization. Bellows then contracts, snapping open the valve ball for a cleaner, more efficient start. On the shut-down, the Bellows expands before pressure drops below the proper atomization point, snapping the valve ball shut, eliminating slow collapse of flame and leaving no oil dribble to foul up nozzle or electrodes.



It took a FLEXIBLE LEAKPROOF BELLOWS to actuate this new Dribble-Proof Burner Valve ... for Minneapolis-Honeywell

Reducing smoky starts and stops and a source of maintenance trouble in high pressure, gun-type oil burners, the Minneapolis-Honeywell Company's new dribble-proof valve features instant, positive control of oil flow.

That's why Minneapolis-Honeywell selected Clifford Hydron Bellows as the actuating mechanism. Immediately responsive to changes in pressure within the nozzle, these entirely leakproof, highly flexible bellows open and close the valve-ball seal so that not the slightest dribble of oil occurs before ignition or after shut-down.

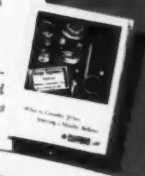
Many Other Uses

Clifford Bellows have been selected by leading manufacturers for the widest range of applications. For example:

(1) Actuating switches or valves for accurate control of temperatures or pressures; (2) Sealing rotary shafts or packless valves against liquid or gas leakage; (3) Providing a flexible joint for instruments combining rotary motion and hermetic seal; (4) Transmitting motion hydraulically to remote points.

What Can They Do For YOU?

Be sure to use the coupon for our free booklet, describing the different types and functions of Clifford Bellows. You may discover, as so many others have done, that these dependable, accurate units can save you time, labor and money. And Clifford engineers will gladly make a confidential analysis of your sketches and specifications — any time, without cost or obligation.



CLIFFORD
HYDRAULICALLY-FORMED BELLOWS AND BELLOWS ASSEMBLIES
ALL-ALUMINUM OIL COOLERS FOR AIRCRAFT ENGINES

Free!

CLIFFORD MANUFACTURING COMPANY, 122 Grove Street, Waltham 54, Massachusetts
Division of Standard-Thomson Corporation
Sales offices in New York 17, Detroit, Chicago 1, Los Angeles

Please send me my copy of the bulletin "What to Consider When Selecting a Metallic Bellows". I am interested in the applications checked.

- ☐ Air conditioning systems
- ☐ Aircraft
- ☐ Carburetor altimeter controls
- ☐ Engine thermostats
- ☐ Gasoline valves
- ☐ High pressure steam devices
- ☐ Heating equipment
- ☐ Instruments
- ☐ Remote or direct control of temperature and pressure
- ☐ Compensating regulators
- ☐ Electric or gas ranges
- ☐ Kilns & ovens — industrial
- ☐ Air compressors
- ☐ Oxygen flow indicators
- ☐ Oxygen regulators
- ☐ Process controls
- ☐ Refrigerating systems — commercial
- ☐ Shaft seal assemblies
- ☐ Fuel pumps
- ☐ Fluid couplings
- ☐ Supercharger controls
- ☐ Refrigerator controls — domestic
- ☐ Torque converters

Other applications .....

Name ..... Title .....

Firm .....

Street .....

City ..... Zone ... State .....

Get the one speed reducer that best fits your job

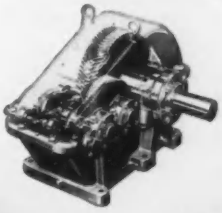
LINK-BELT builds all three types of enclosed gear drives

NO ONE speed reducer solves *every* reduction problem. That's why Link-Belt builds all three — Worm, Helical and Herringbone Gear Drives. Your Link-Belt power transmission engineer will recommend the *right* reducer for your needs.

You can be sure you get the one that suits all your requirements for ratio, space, shaft position, shock loading and many other factors. Precision-engineered for quiet, economical power transmission, all Link-Belt drives will give you long service under the toughest operating conditions.

On Worm Gear Drives, write for Book 2324-A

On Gearmotor and Helical Gear Drives, write for Book 2247

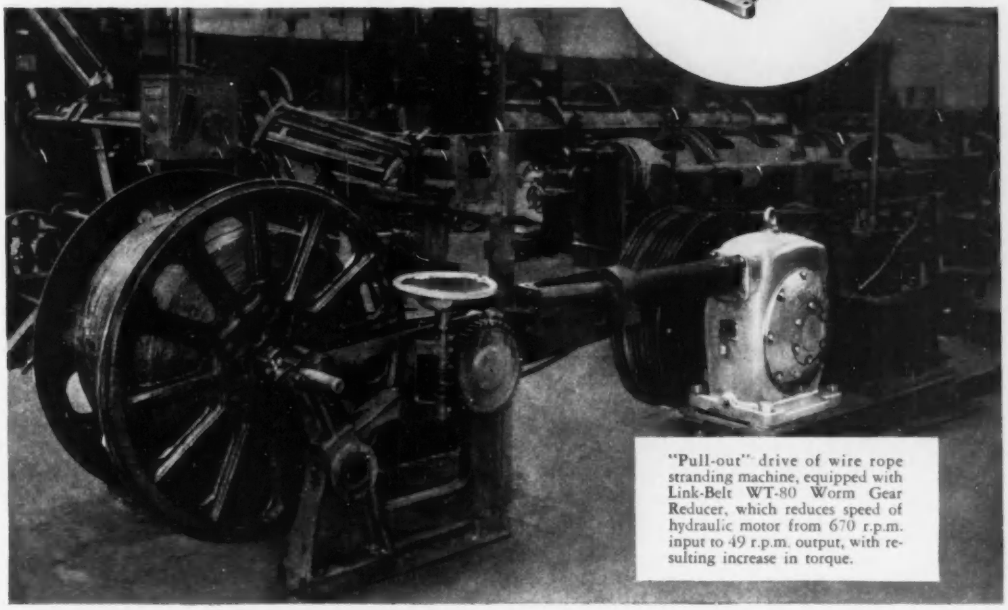


On Herringbone Gear Drives, write for Book 2419

LINK-BELT

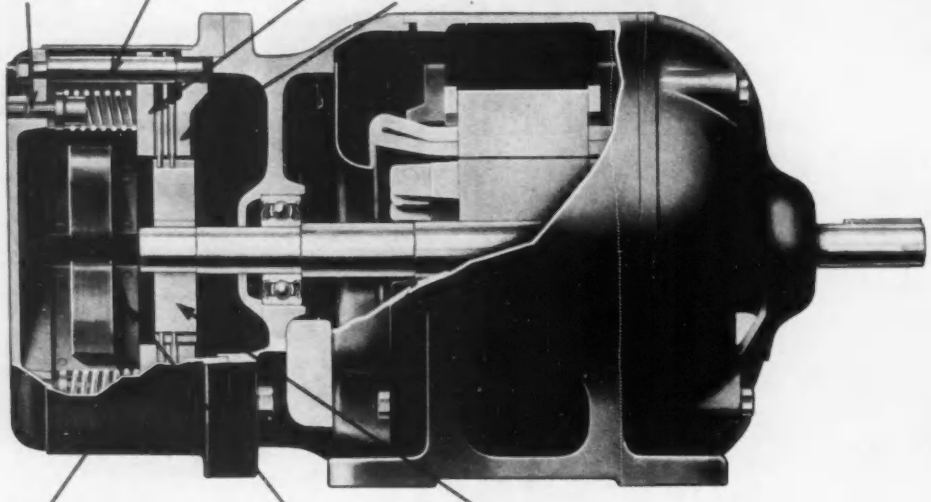
ENCLOSED GEAR DRIVES

LINK-BELT COMPANY: Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Afric.). Offices, Factory Branch Stores and Distributors in principal cities. 12.416-A

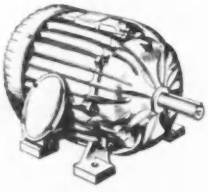


"Pull-out" drive of wire rope stranding machine, equipped with Link-Belt WT-80 Worm Gear Reducer, which reduces speed of hydraulic motor from 670 r.p.m. input to 49 r.p.m. output, with resulting increase in torque.

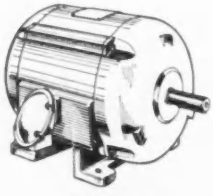
Here's a


Oversize brake studs absorb torque.
Magnet armature plate.
Readily accessible torque adjusting screws.
All-metal brake disc.
Wrap-around band cover, for totally-enclosed protection and easy removal.
Core plated "E" magnets. Readily accessible. Location keeps heat away from motor.
Large brake spline with many teeth.

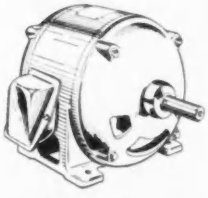
Other ELLIOTT C-W motors for special and general use . . .



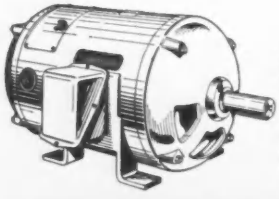
TYPE CFC
Squirrel cage, "Sealed Power," Totally-Enclosed, Fan-cooled



TYPE BE
Squirrel cage, Totally-Enclosed, Non-Ventilated



TYPE BA
Squirrel cage, open-drip-proof (protected)



TYPE BW
Wound rotor, Open-drip-proof (protected)

Other Elliott products include: Turbine-Generators • Deaerating Heaters • Generators • Turbochargers • Strainers • Centrifugal Blowers • Condensers • Mechanical Drive Turbines • Steam Jet Ejectors and Tube Cleaners.

ELLIOTT COMPANY

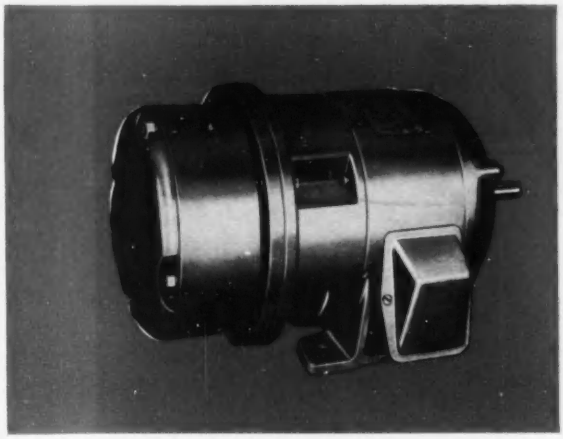
General Offices & Main Plant—Jeannette, Pa.

brake that can take it!

The Elliott CROCKER-WHEELER BRAKE MOTOR

QUICK STOPS AND STARTS are taken in every day stride by this rugged brake motor. Its all-metal *bonded* brake linings dissipate heat faster, wear longer and are immune to dampness, cold and other "brake killers." In performance, the powerful magnetic braking action is instantaneous—and sure.

Moreover, the Elliott C-W brake is tops in compactness and adaptability. It can be mounted on double shaft extension NEMA standard D flange or C face motors without the need of mounting brackets or adapters. Teamed with an efficient Elliott C-W motor (protected or totally-enclosed types), it's a combination that's hard to match.



The Elliott C-W Brake-Motor. Note the simple, wrap-around cover on the brake to give totally-enclosed protection.

SEND FOR THIS BULLETIN

It gives you all the details of construction and applications. Ask for BRAKE MOTOR BULLETIN SL-610-1 and address your request to Elliott Co., Dept. PE, Jeannette, Pa.

ELLIOTT C-W motors range from 1 to 200 hp. Large ELLIOTT motors and generators are built by the RIDGWAY DIVISION in Ridgway, Pa.

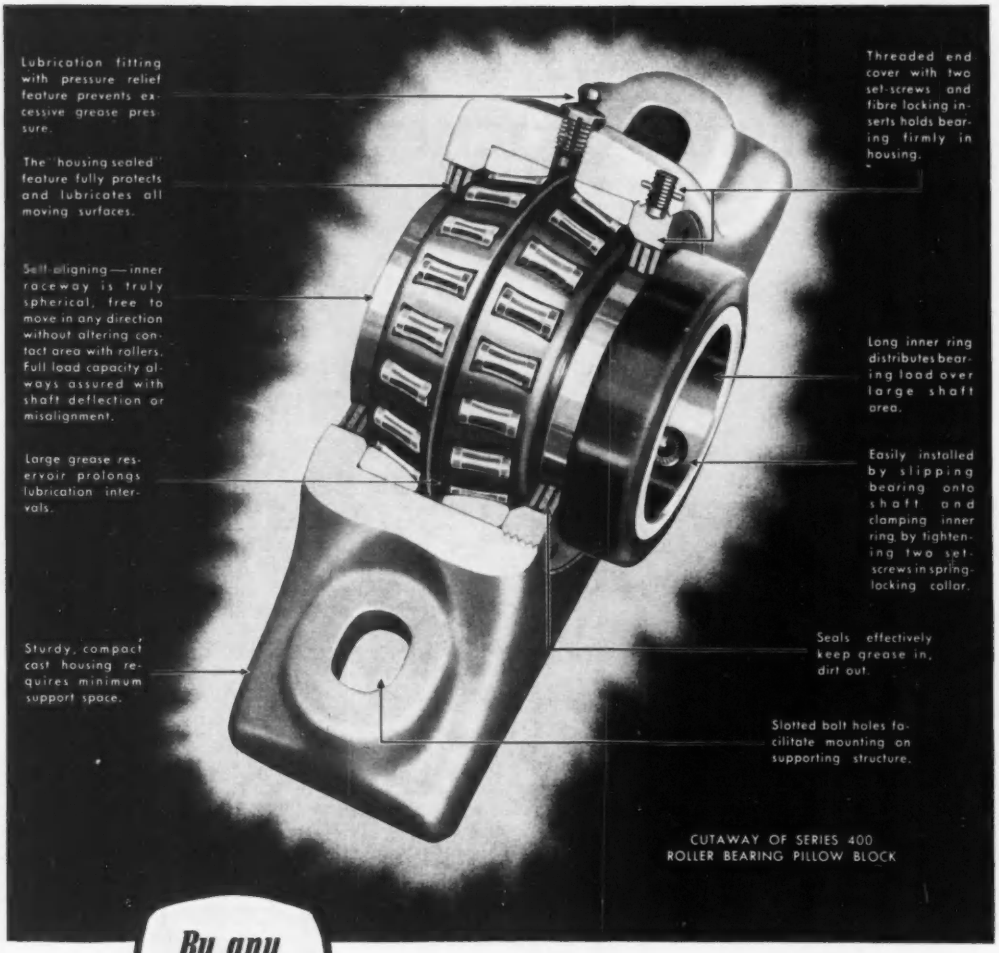
CW-23

CROCKER-WHEELER DIVISION
AMPERE, N. J.

BRANCH OFFICES AND REPRESENTATIVES IN PRINCIPAL CITIES
ELLIOTT *Approved* SERVICE SHOPS COVER THE COUNTRY

HALF CENTURY OF 1901 E Co 1951 POWER PROGRESS

LINK-BELT Ball and Roller Bearings smooth the path of power


Lubrication fitting with pressure relief feature prevents excessive grease pressure.
The "housing sealed" feature fully protects and lubricates all moving surfaces.
Self-aligning — inner raceway is truly spherical, free to move in any direction without altering contact area with rollers. Full load capacity always assured with shaft deflection or misalignment.
Large grease reservoir prolongs lubrication intervals.
Sturdy, compact cast housing requires minimum support space.
Threaded end cover with two set-screws and fibre locking inserts holds bearing firmly in housing.
Long inner ring distributes bearing load over large shaft area.
Easily installed by slipping bearing onto shaft and clamping inner ring by tightening two set-screws in spring-locking collar.
Seals effectively keep grease in, dirt out.
Slotted bolt holes facilitate mounting on supporting structure.
CUTAWAY OF SERIES 400 ROLLER BEARING PILLOW BLOCK

By any standard . . . **LINK-BELT Bearing Blocks offer strength plus economy**

POUND-FOR-POUND you can't beat the bearing strength and long life of Link-Belt Ball and Roller Bearings. Take the Series 400 Roller Bearing Pillow Block, for example. Built for shaft sizes from ¾ to 4 in., this bearing has an "average life" up to 100,000 hours . . . radial load ratings up to 61,000 pounds. A Link-Belt bearing specialist will help you apply any of the broad Link-Belt line. And you'll find complete engineering information in Data Book 2550.

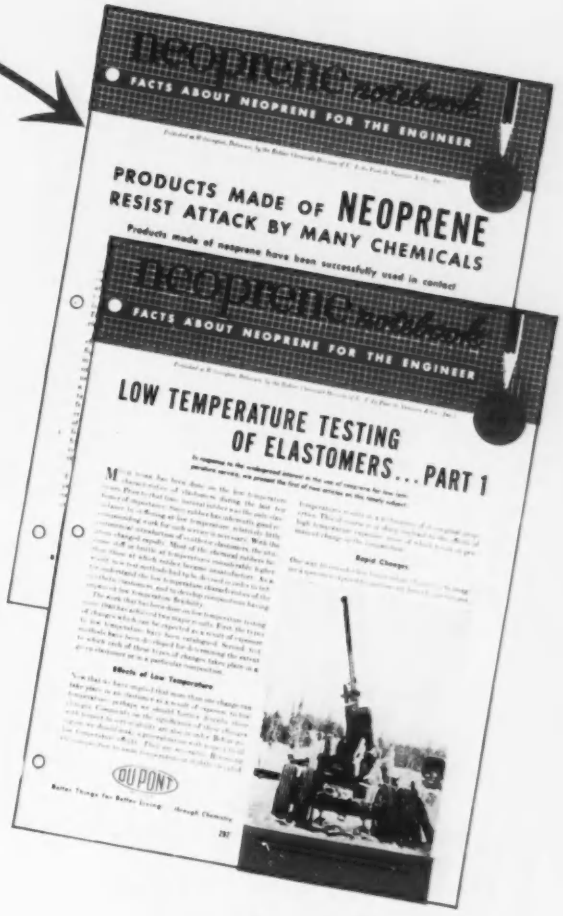
LINK-BELT

BALL AND ROLLER BEARINGS

LINK-BELT COMPANY: Indianapolis 6, Chicago 9, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa). Offices, Factory Branch Stores and Distributors in principal cities. 12.410

Timely Facts and Features You'll Find in the NEOPRENE NOTEBOOK

- how you can reduce maintenance costs
- ways to solve many production problems
- new ideas on neoprene's wide range of uses
- technical help in specific applications
- details of new improvements in old products
- interesting new neoprene products


neoprene notebook
FACTS ABOUT NEOPRENE FOR THE ENGINEER
PRODUCTS MADE OF NEOPRENE RESIST ATTACK BY MANY CHEMICALS
neoprene notebook
FACTS ABOUT NEOPRENE FOR THE ENGINEER
LOW TEMPERATURE TESTING OF ELASTOMERS... PART 1
DU PONT

YOU'LL FIND PROFITABLE READING in every issue of the Neoprene Notebook. Informative, up-to-the-minute articles on neoprene's properties, performance, and new neoprene products help you step up production efficiency and cut expenses. The feature articles in the two issues shown here are good examples of the authoritative reports that appear regularly. Pictures, graphs and charts make for easy, thorough understanding. Each issue is packed from cover to cover with new ideas to save you time, and money. Put your name on our mailing list. Subscriptions are FREE.

NEOPRENE

The rubber made by Du Pont since 1932

DU PONT

BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

CLIP THIS COUPON AND MAIL IT TODAY

E. I. DU PONT DE NEMOURS & CO. (INC.)
Rubber Chemicals Division, B-11
Wilmington 98, Delaware

Please send me free issues of the Neoprene Notebook.

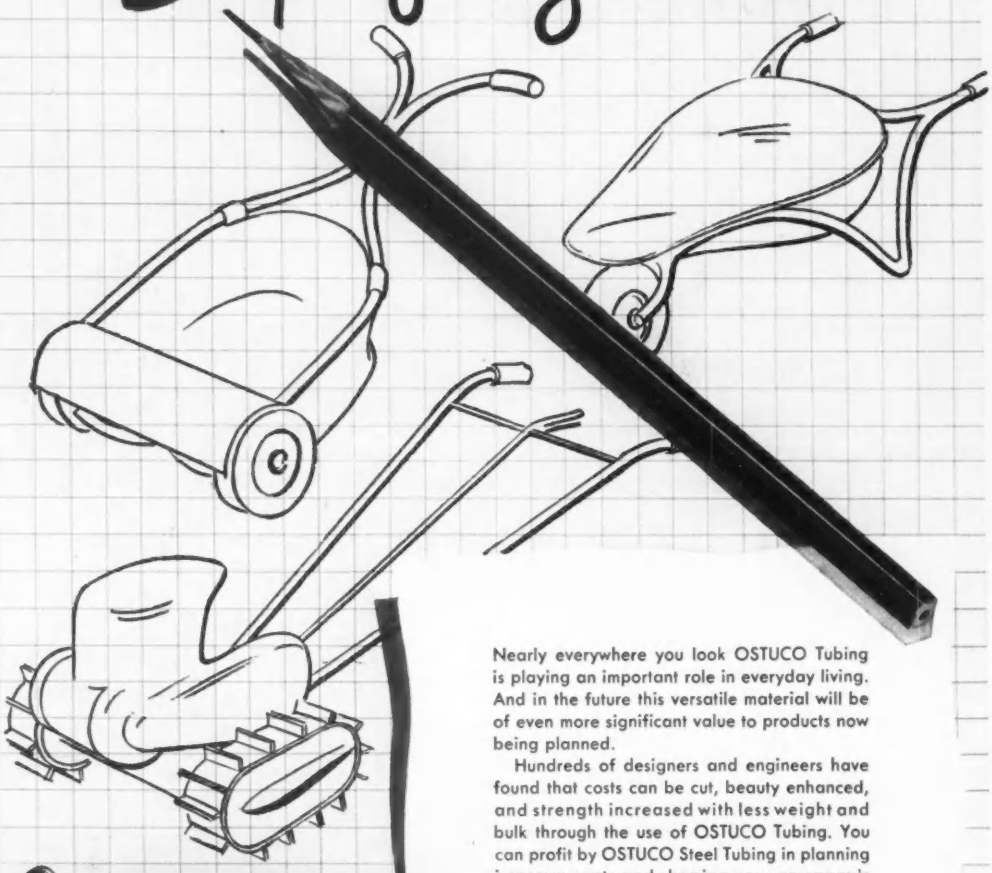
Name_____

Position_____

Firm_____

Address_____

Shape of things to come...



From Your Blueprint . . . to Your Product

OSTUCO TUBING

Tapering • Swaging • Flanging • Bending
Upsetting • Expanding • Reducing • Beading
End closing • Spinning • Drilling • Slotting
Notching • Flattening • Shaping • Trimming
Threading • Angle Cutting • And Many Others

Nearly everywhere you look OSTUCO Tubing is playing an important role in everyday living. And in the future this versatile material will be of even more significant value to products now being planned.

Hundreds of designers and engineers have found that costs can be cut, beauty enhanced, and strength increased with less weight and bulk through the use of OSTUCO Tubing. You can profit by OSTUCO Steel Tubing in planning improvements and shaping your company's future products.

Because of military demands, we cannot always promise early delivery estimates on new civilian orders. Meanwhile, however, call upon our experienced tubing engineers and take advantage of OSTUCO Steel Tubing in your plans for the future.

THE OHIO SEAMLESS TUBE COMPANY

Manufacturers and Fabricators of Seamless and Electric Welded Steel Tubing

Plant and General Offices: SHELBY 7, OHIO

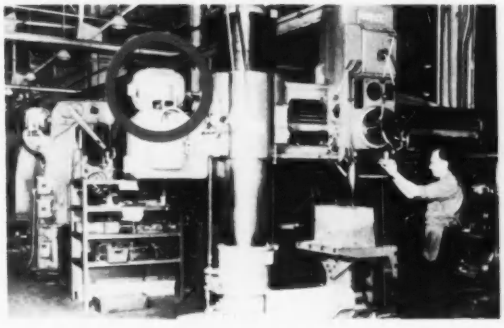
SALES OFFICES: BIRMINGHAM, P. O. Box 2021 • CHICAGO, Civic Opera Bldg., 20 N. Wacker Dr. • CLEVELAND, 1328 Citizens Bldg. • DAYTON, 511 Salem Ave. • DETROIT, 520 W. Eight Mile Road, Ferndale • HOUSTON, 6833 Avenue W, Central Park • LOS ANGELES, Suite 300-170 So. Beverly Drive, Beverly Hills • MOLINE, 617 15th St. • NEW YORK, 70 East 45th St. • PHILADELPHIA, 1613 Packard Bldg., 15th & Chestnut • PITTSBURGH, 1206 Pinewood Drive • ST. LOUIS, 1230 North Main St. • SEATTLE, 3104 Smith Tower • SYRACUSE, 501 Roberts Ave. • TULSA, 733 Kennedy Bldg. • WICHITA, 622 E. Third St. • **CANADIAN REPRESENTATIVE:** RAILWAY & POWER CORP., LTD.

"We have three shifts in operation," says Julius J. Domonkos, Vice-President in Charge of Manufacturing, Bell Aircraft Corporation. "That's full production on a 24-hour day basis. For the past 10 years we've been depending on Tri-Clad motors to carry the load. We've never regretted putting our confidence in this fine motor!"

G-E Tri-Clad Motors drive the machines that are instrumental in producing helicopters, guided missiles, rocket motors, research aircraft, and jet aircraft engine nacelles for our rapidly expanding armed forces. At Bell Aircraft Corporation, G-E Tri-Clads are known as a thoroughly dependable motor —tough on the outside . . . on the inside . . . at the bearings.

BELL AIRCRAFT CORPORATION:

"We've been depending on Tri-Clad* Motors for Ten Years . . ."



This Tri-Clad driven radial drill takes care of most of the large dies for the entire Bell plant. Big dies and bolster plates are drilled and tapped on this machine, a critical part of the Bell operation. Despite continuous use, plant personnel can't remember a single interruption due to Tri-Clad failure!

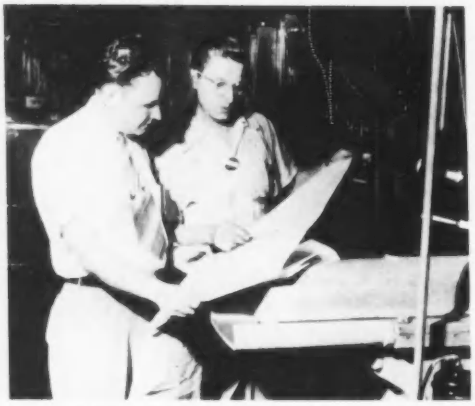
*Reg. trademark of General Electric Co.

FASTEST BOMBER IN THE WORLD! Jet engine nacelles for the 600-plus miles-per-hour B-47 are being produced at a record-breaking clip in the Bell plant at Buffalo, N. Y. The "Stratojets" represent a major advance in bombardment aircraft.

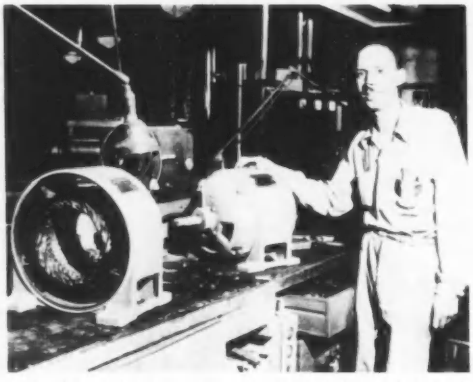
GENERAL ELECTRIC

TRI CLAD MOTORS

Help keep Bell Aircraft production up!

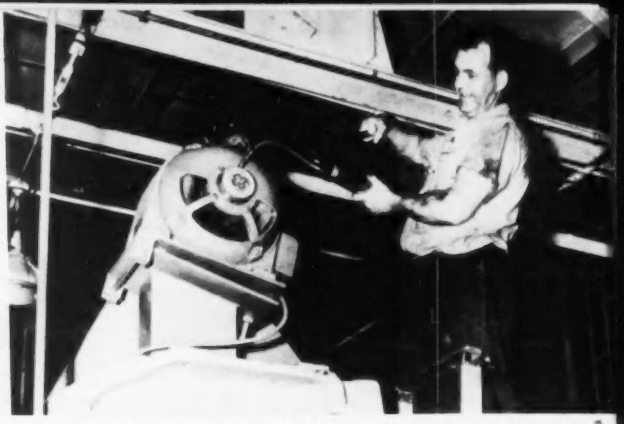


Marvin Limburg (left), Foreman of Bell's Tool and Die Shop, comments, "I don't believe we've ever lost machine time due to breakdown of Tri-Clad motors. And our jig-borers, for example *have been operating around the clock for the last 8 to 10 years!*"

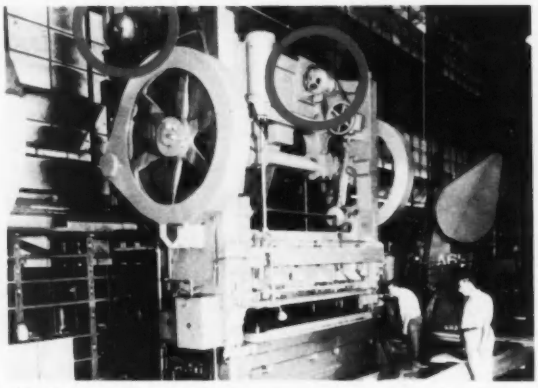


"It's the easiest motor we have to maintain" according to Maxwell Anderson, Crew Chief of Bell's motor repairmen. "There's more working room inside and more room in the slots. It's become a byword with us that if you give a Tri-Clad motor ordinary care you'll never have to worry about maintenance."

TIMELY READING—With every electric motor needed on the line, you'll want a copy of the G-E manual on "How to Maintain Motors and Generators." It's free; just ask for bulletin GET-1202. *Sect. 752-10, General Electric Company, Schenectady 5, N. Y.*



Greasing isn't necessary on a Tri-Clad motor in normal service, but it's always reassuring to know that you *can* lubricate if you so desire, without time-consuming disassembly. The photo shows how easy it is: remove relief plug, attach the grease gun nozzle, squirt—the job is finished.



This huge punch press is an important tool maker. Anton Geiser (right), assistant punch press foreman, says: "I can't recall a single shutdown of this section due to motor failure." Almost all motors in this department are Tri-Clad. This is another Bell Department which has been operating around the clock; cannot afford to lose time because of motor breakdown.

NEW! A Helpful Training Course on Motors!

Everyone concerned with technical training problems will want this new G-E Motor Selection and Application Course. Consists of 9 short, easily understood lessons. Complete kit —slide films, review booklets and instructor's manual— $100.00. Call or write your nearest G-E sales office.

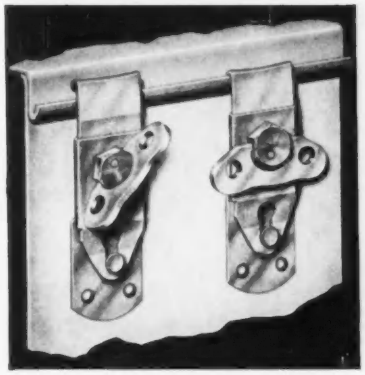
Look at the Scope of this Course

1. Fundamentals of Motors
2. Types of Motors
3. Fundamentals of Selection
4. A-C Induction Motors
5. Single-phase Motors
6. D-C Motors
7. Synchronous Motors
8. Adjustable-speed Drives
9. Gear Motors

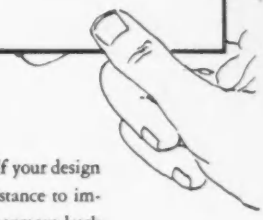
GENERAL ELECTRIC

Have you a similar fastening problem?

File: Simmons LINK-LOCK



When the armed forces needed a positive, high-strength fastening device for instrument housings, transit cases, and storage boxes, Simmons developed LINK-LOCK. This *brand-new* device doesn't use springs, yet works with fingertip pressure through a unique mechanical arrangement: the vertical sliding latch is moved in and out of locking position by a disc rotated with a wing nut. The fastener is immune to low temperatures, is easy to operate even with arctic mittens, furnishes up to 450-lb. pull-down pressure. Open or closed, it lies flat against the side of the case it fastens.



LINK-LOCK may be the answer to your fastening problem. If your design involves heavy fastening pressures, watertight sealing, high strength, resistance to impact, ask about LINK-LOCK. Simmons can furnish it with special engagement-latch details, or for operation by bolt or screwhead instead of wing nut. Write for LINK-LOCK DATA SHEET today. It gives complete details and dimensions. A Simmons engineer will be glad to work with you on your fastening problems.

SIMMONS FASTENER CORPORATION, 1751 No. Broadway, Albany 1, New York

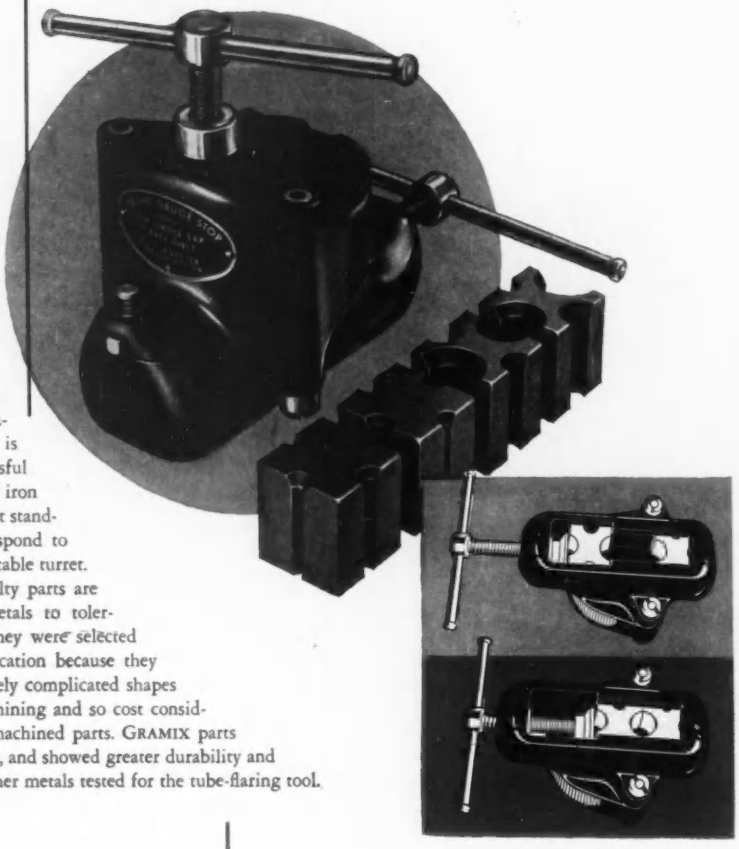
Simmons

LINK-LOCK
QUICK-LOCK
SPRING-LOCK
ROTO-LOCK

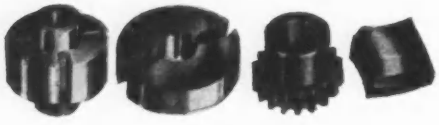
FASTENERS WITH USES UNLIMITED

precision formed GRAMIX® *die blocks*

prove their quality in this powerful little tube-flaring tool



The new Papco Roto-Master Tube-Flaring Tool made by the Penn Aircraft Products, Inc. of Dayton, Ohio has greatly simplified single or double lap flaring on all grades of tubing for oil and hydraulic line installations in aircraft. And GRAMIX is mighty important to the successful operation of this tool. Four iron GRAMIX die blocks provide eight standard tube diameters that correspond to the eight stations of the adjustable turret. GRAMIX bearings and specialty parts are die-pressed from powdered metals to tolerances as close as .0005". They were selected by Papco for this application because they can be produced in relatively complicated shapes that require little or no machining and so cost considerably less than machined parts. GRAMIX parts are strong and tough too, and showed greater durability and longer life than other metals tested for the tube-flaring tool.



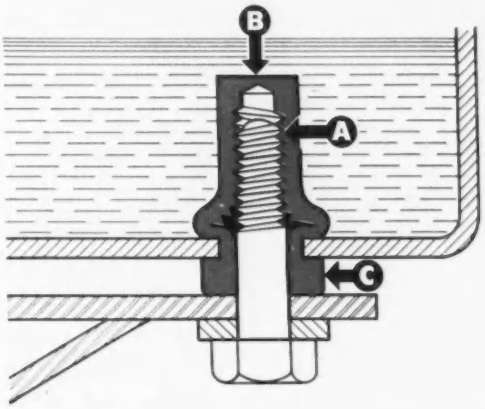
GRAMIX parts are self-lubricating. Whatever your operation may be, we think you'll find that GRAMIX bearings and specialty parts will help cut costs and improve the performance of your product. For complete information, write today to . . .

87

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

RIVNUT replaces nut plate on oil tank . . . eliminates leaking, warping, thread cleaning



A MANUFACTURER of industrial oilers was brazing nut plates on his reservoir tanks for bolting to brackets. This sometimes caused leaks and warping. Since painting had to follow brazing, the threads had to be retapped.

By switching to Rivnuts, brazing was eliminated. Installed from one side, after painting, in one-tenth the time required for brazing, Rivnuts provide at least six clean threads (A) to take the attachment bolt. Rivnut forms oil-tight seal, has closed end (B). Special spacer head (C) of Rivnut forms uniform height feet.

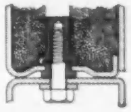
Closed-end Rivnut with spacer head is one of many types of Rivnuts. If you have a fastening problem, consult a Rivnut engineer. Write to The B. F. Goodrich Company, Dept. PE-111, Akron, Ohio.

What's your toughest fastening problem?

TORQUE?

Special Rivnuts with splined shafts or key (above) supply needed torque resistance.

SEAL?



Firm grip of upset Rivnut on material, plus special closed end, gives tight seal.

MATERIAL?

Even in thin materials, Rivnuts provide at least 6 threads for attachment.

ATTACHMENT?

Fasten *with* Rivnuts—fasten *to* Rivnuts. Makes possible multiple fastening.

FINISH?

Rivnuts can be installed after finish, such as paint or porcelain, is applied.

LOAD?

Typical Rivnut thread strength: 6-32—964 lbs.; 8-32—1096 lbs.; 10-32—1326 lbs.*

RIVNUTS *lick them all!*

**Figures given for aluminum. Loads for brass and steel Rivnuts about double.*

B.F.Goodrich

RIVNUTS

The only one-piece blind rivet with threads

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how you can use Rivnuts to fasten TO *and* fasten WITH. Explains construction, gives proved applications . . . Write for your free copy today to The B. F. Goodrich Company, Department PE-111, Akron, Ohio.

Shaking the bugs out of a new screening idea

When Southwestern Engineering Company, of Los Angeles, came up with the idea of a screen separator with "bumps *and* grinds"—bouncing *and* vibrating action—they knew they had something.

Something that might speed up sluggish separating processes tremendously. In oil, for example, where the "sluggard" is mud... in fruit processing where it's pectin, juices and purees... in ceramics where it's a silica-clay-talc-water slurry called "slip."

The idea was swell. But working it out, finding the right metal for the cylinders, was a lulu.

They'd try one. It wouldn't meet the acid test ...quite. And would contaminate some products ever so slightly, but ever so disastrously.

They'd try another. Tons of jiggling mix would eventually break its back.

Still another. The cylinders would keep splitting at the seams.

Finally, they tried Monel. And they were in. No more trouble, no matter how much machines were overloaded or over-speeded!

First to take advantage of this new Sweco development was Gladding McBean & Co.

They installed the two Sweco separators shown here to screen clay slip for their famous "Hermosa" wall and floor tile. And by so doing, they improved their product because they were able to use a finer clay ... boosted production because they could handle slip with only 40% instead of 51% water (thereby saving about 35% on fuel costs in the subsequent drying)...and increased the life of the screen cloth from *4 days to 26 months!*

Now what about your metal problem?

Could one or another of the Inco Nickel alloys help solve it? Very possibly. Write us about it. Even though Nickel is being diverted to defense, we are ready right now to help you with ideas and suggestions for your present production and future planning.

The International Nickel Company, Inc.
67 Wall Street, New York 5, N. Y.

OVER-ALL IN SERVICE
NICKEL (INCO) ALLOYS

MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL
"S"® MONEL • NICKEL • LOW CARBON NICKEL
DURANICKEL® • INCONEL® • INCONEL "X"®

Custom-made **SYLPHON STAINLESS STEEL** bellows assemblies

DEFENSE WORKERS

...against product troubles and expense!

If you're looking for a way to relieve yourself of the problems of producing stainless steel bellows assemblies, look to Fulton Sylphon or Bridgeport Thermostat. For bellows assemblies—simple or complex—are a specialty with us. Fact is, they have been for nearly half a century.

Your requirements and specifications can be met exactly. That can be a big help to you—save you time and money. For we have the skilled craftsmen, the facilities, and the ability to produce for you in any volume—on schedule.

Sylphon bellows assemblies are used in many ways, in practically all industries . . . where there's a design problem involving control of temperatures and pressures. They open and close valves, dampers, etc., absorb expansion, provide packless construction, have many more uses.

Your problem may parallel one we have solved for another customer. Or, we'll work with you to develop an assembly *specifically adapted* to your needs. Stainless steel and other metals. Wide size range. Write for information. Ask for idea-filled Catalog VP-1200.

TEMPERATURE CONTROLS

FULTON SYLPHON DIVISION Knoxville 4, Tenn.

Robertshaw-Fulton CONTROLS COMPANY

BELLOWS ASSEMBLIES • BELLOWS DEVICES

BRIDGEPORT THERMOSTAT DIVISION Bridgeport 1, Conn.

For FULLEST protection

against shorted wiring — use NEW T & B Self-Insulated Sta-Kon Terminals...SAVE AN EXTRA INSULATING OPERATION

NOW... end the risk of shorts between closely-mounted terminals—and do it the quick, economical way—by using T & B Self-Insulated Sta-Kon Terminals.

Metallic portion of these new components retains all the proved-over-the-years advantages of the Sta-Kon design—high conductivity, low contact resistance, lastingly strong grip on wire. The insulation—a special nylon formula which forms an integral part of the terminals *as shipped* and *as assembled*—absolutely prevents metal-to-metal contact between adjacent terminals. Self-Insulated Sta-Kons do away with the need for separate insulating sleeves . . . and save an extra insulating operation.

MANY INSULATION PLUSES

The insulation, selected after exhaustive tests as the best material available for severe service, combines exceptionally high impact strength with light weight. Its mechanical and electrical qualities are unaffected by installation. It successfully withstands the action of gasoline, naphtha, hydraulic fluids, many other chemical agents . . . as well as the effects of high temperatures.

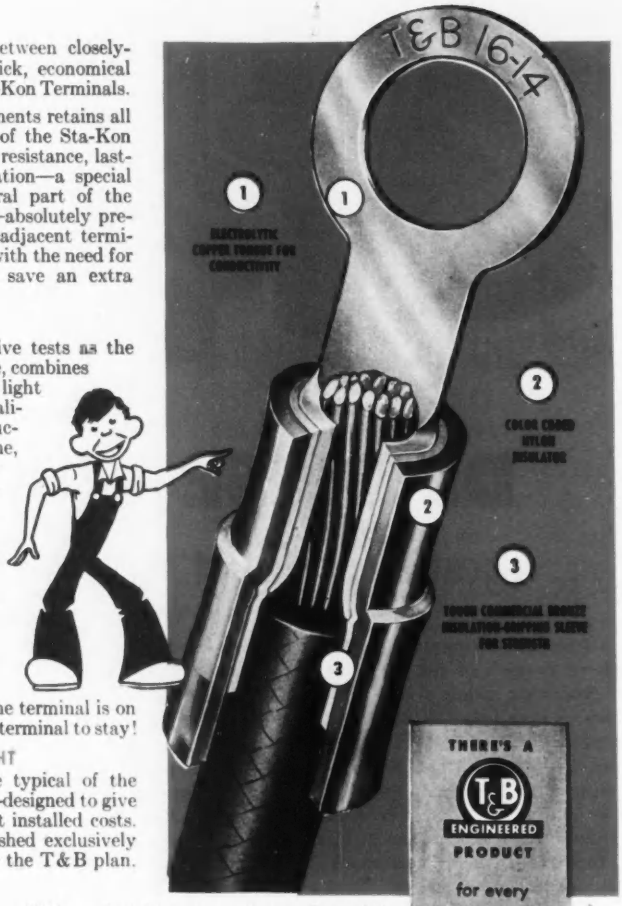
Insulation is *molded* for permanent dimensional accuracy . . . *color coded* for easy identification . . . *translucent* for visual inspection of assembly.

SIMPLE, SURE INSTALLATION

A single operation with Shure Stake Tools* *simultaneously* stakes terminal to wire with terrific pressure, and grips the insulation permanently in place. The terminal is on the wire to stay; the insulation is on the terminal to stay!

ENGINEERED RIGHT...DISTRIBUTED RIGHT

Self-Insulated Sta-Kon Terminals are typical of the many T & B quality fittings recently re-designed to give you outstanding performance at lowest installed costs. Like all T & B fittings, they're furnished exclusively through local T & B distributors under the T&B plan.



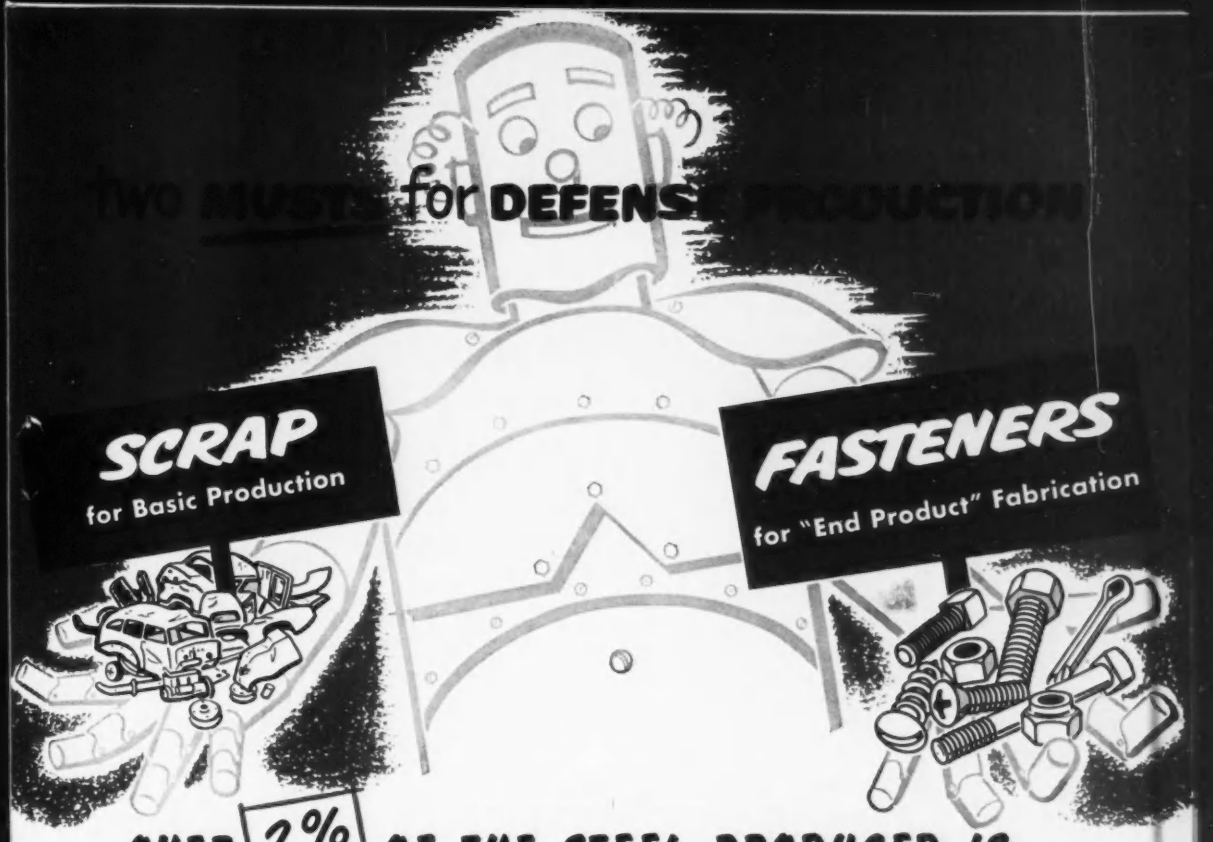
SHURE-STAKE HAND TOOLS exert more than 2,000 pounds staking pressure (compared with 800 pounds for ordinary tools.) Once pressure has been applied, jaws cannot be opened until dies have closed all the way home to exert full pressure. Air operated tools also available, in hand-held and bench-mounted types.

THERE'S A T&B ENGINEERED PRODUCT for every wiring job in the complete T & B line of fittings for all conductors and raceways.

THE THOMAS & BETTS CO. INCORPORATED
16 Butler Street, Elizabeth 1, New Jersey

MANUFACTURERS OF ELECTRICAL FITTINGS SINCE 1898
ORIGINATORS OF SELF-INSULATED SOLDERLESS TERMINALS IN 1935

Our Field Service Engineers are ready to help you on special fittings problems. Ask your nearest T & B wholesaler to arrange to have one get in touch with you.



OVER 2% OF THE STEEL PRODUCED IS USED TO FASTEN THE REST TOGETHER . . .

Steel is a basic commodity. Upon our ability to produce steel, and more steel, rests the success of our rearmament program and the very security of our country.

Scrap is an important ingredient of new steel. More and more scrap will be required as production expands.

But what about the end products of steel—the machinery, the weapons, the vehicles, the thousands of products fabricated from steel? That's where fasteners are a MUST. Without fasteners most of the steel produced would be of little use.

So when you think of steel as an important commodity, think of fasteners, too. *Both* are vital to our industrial economy and to the success of our defense effort!

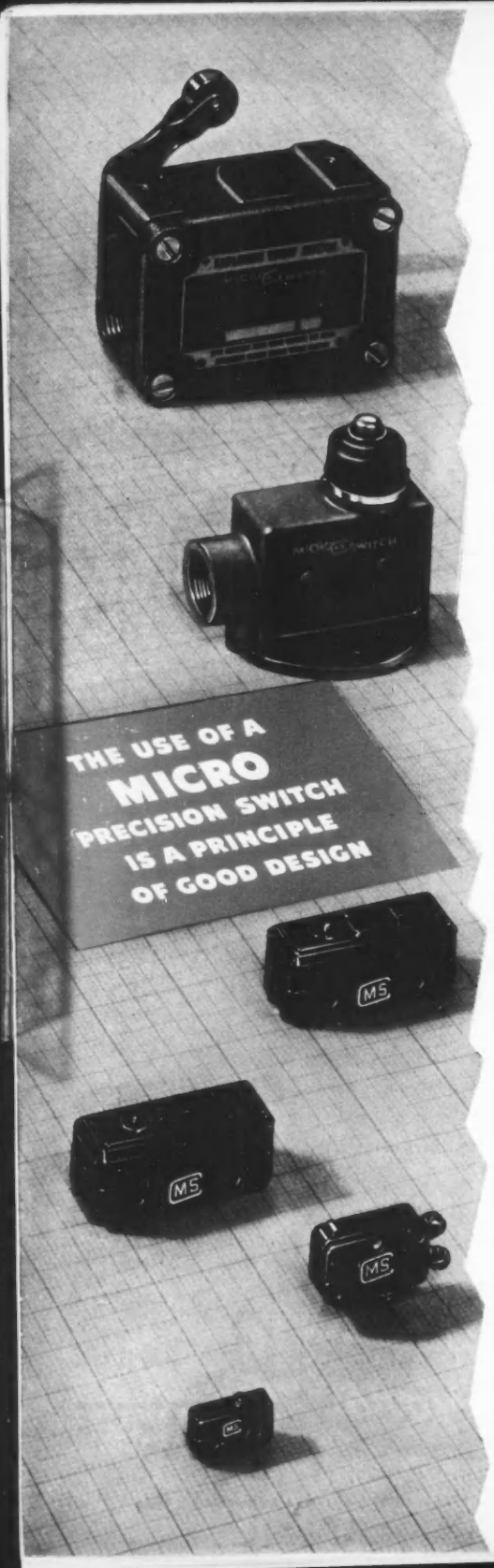
The home of "quality controlled" fasteners

Lamson + Sessions

L S

The **LAMSON & SESSIONS** *Co.* • • **General Offices: 1971 West 85th Street • Cleveland 2, Ohio**

Plants at Cleveland and Kent, Ohio • Birmingham • Chicago



MICRO SWITCH

to meet every

MICRO SWITCH does not make *"A* switch." MICRO SWITCH makes — or can make — snap-action controls to meet practically every requirement where precision switching of electrical current is involved.

These lightweight, small, precise switches are supplied with easily mounted housings to meet rugged operating conditions such as shock, vibration, exposure to dirt, dust, splash or hazardous atmosphere. They are available with actuators to meet the most complex installation problems. Their extremely small size, accurate repeatability and unusually long life make them ideal components for modern streamlined designs.

MICRO SWITCH field engineers have worked with design engineers in every phase of industry in the development of over 5000 different types of characteristics, housings, mountings, actuators, each to meet the specific requirements of a specific design.

This field service is available to you, to assist you in the selection of the exact MICRO precision switch to make your product economical to build and precise in operation — and to assure long-life, trouble-free use. Contact the nearest MICRO SWITCH branch office today. It may save you time and money.

A DIVISION OF

can supply a precision switch electrical switching requirement

Richards-Wilcox Engineers find a MICRO Precision Switch is "good design" in elevator safety door edge.

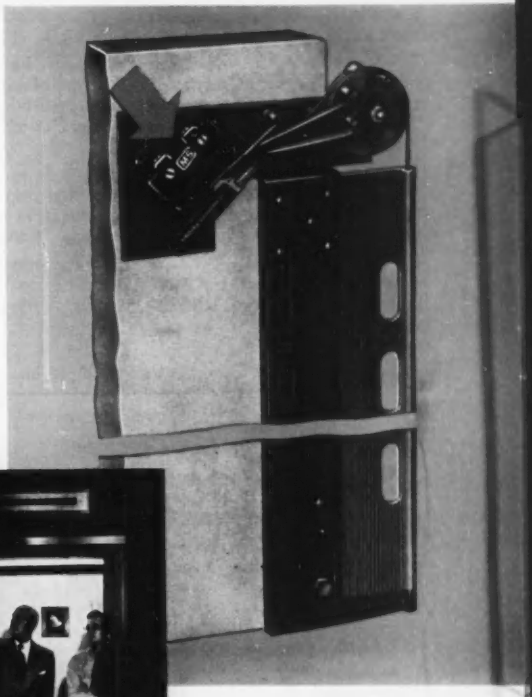
Among the many diversified products of Richards-Wilcox Mfg. Co., world's largest manufacturers of door hangers and tracks, is a safety door edge for passenger elevators.

This device is designed to prevent a person or object from being caught between door and jamb while the cab doors are closing.

Essentially, the safety door edge consists of a molded rubber edge which encases a steel cable. This cable extends along the door's entire height, over a cable sheave, and thence to a spring which holds the cable taut.

Pressure against the cable, as by a person not entirely clear of the elevator doors, actuates a MICRO precision switch. This instantly reverses the door movement, permitting safe passage to or from the cab.

Richards-Wilcox engineers selected a MICRO precision switch for this application because of its small size, to fit into limited space; extreme sensitivity; capacity for long-lived dependability; and plenty of overtravel without harm to equipment.



Illustrated is the use by Richards-Wilcox of the small, precise Type "W" leaf-actuated MICRO precision switch. Located at the top of the door, the switch is actuated by the dog on the sheave pulley when door cable is tightened by pressure against the door edge.

MICRO MS SWITCH

FREEPORT, ILLINOIS

MICRO Snap-Action Switches . . . Honeywell Mercury Switches

MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

Can You Use a HEAVY liquid?

Can you use a heavy liquid that has contributed greatly to simplifying design and fabrication of certain products?

Acetylene tetrabromide is an unusually heavy liquid with a specific gravity of 2.95. In the absence of sunlight, acetylene tetrabromide is stable in dry air. And, when sealed in an opaque container, it will not break down.

Acetylene tetrabromide is comparatively inexpensive and finds wide use as a gauge fluid and as the movable part in vibration dampeners. It is also used for mineral separation by specific gravity.

GIVE A SEARCHING LOOK at the properties of acetylene tetrabromide. Then, if you desire further information or technical service, write or wire Dow.

$C_2H_2Br_4$

Properties:

Clear, colorless liquid with a mild sweet odor.

Specific gravity at 25/25°C.	2.953
Pounds per gallon at 25°C.	24.57
Boiling point at 15 mm. Hg	119°C.
Freezing point	0.0°C.
Fire point	None
Flash point	None

Solubility, grams per 100 grams solvent:

Alcohol at 25°C.	∞
Carbon Tetrachloride at 25°C.	∞
Chloroform at 25°C.	∞
Ether at 25°C.	∞
Water at 30°C.	0.065
Water at 80°C.	0.28

THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN

Send for free sample of ACETYLENE TETRABROMIDE

The Dow Chemical Company
Dept. OC- 20A
Midland, Michigan

Name_____ **Title**_____

Company_____

Address_____

City_____ **State**_____

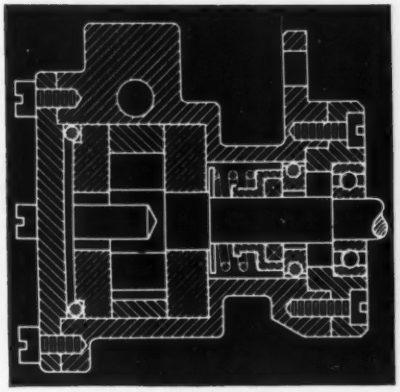
DOW

CHEMICALS

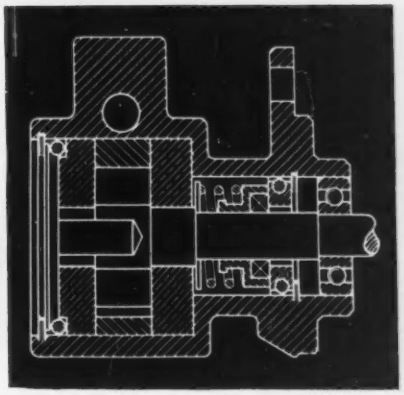
INDISPENSABLE TO INDUSTRY AND AGRICULTURE

TWO TRUARC RINGS IN NEW PRESSURE PUMP SAVE $1.48 PER UNIT

OLD WAY Requires 4 skilled-labor threading operations...4 heavy screws on a cover plate and an internal tapped thread, plus plug at rear. Assembly is slow and difficult...maintenance necessary.



NEW WAY Just 2 Truarc Rings, set into accurately predetermined grooves, bring new simplicity of design... speedy assembly. No skilled-labor required! No maintenance! Rings lock parts accurately for life of unit.



Using 2 Waldes Truarc Retaining Rings in their new Pump, saved the Procon Pump & Engineering Co., Detroit, $1.48 per unit! With Truarc Rings, assembly is speedy, simple. Skilled-labor threading operations ...stripped threads...maintenance are eliminated. Parts are firmly held together for life of unit!

Redesign with Truarc Rings and you, too, will cut costs. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better job of holding parts together.

Truarc Rings are precision-engineered...quick and easy to assemble and disassemble. Always circular to give a never-failing grip. They can be used over and over again.

Find out what Truarc Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation. Waldes Truarc Retaining Rings are available for immediate delivery from stock, from leading ball bearing distributors throughout the country.

USE OF 2 WALDES TRUARC RINGS PERMITTED THESE BIG SAVINGS:

Eliminated 2 castings	$ .39
Eliminated 8 screws	.04
Eliminated machining of 2 castings	.56
Eliminated drilling and tapping housing	.40
Reduced assembly time by elimination of screws	.09
TOTAL SAVINGS	**$1.48**
Weight saved	14 ounces

For precision internal grooving and undercutting... Waldes Grooving Tool.

SEND FOR NEW BULLETINS ➡

WALDES TRUARC

REG. U.S. PAT. OFF.

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 2,382,947; 2,382,948; 2,410,052; 2,420,021; 2,420,361; 2,439,705; 2,441,646; 2,455,165; 2,483,380; 2,483,383; 2,487,002; 2,487,003; 2,491,304; 2,500,081 AND OTHER PATENTS PENDING.

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send engineering specifications and data on Waldes Truarc Retaining Ring types checked below. PM113

- ☐ Bulletin #5 Self-locking ring types
- ☐ Bulletin #6 Ring types for taking up end-play
- ☐ Bulletin #7 Ring types for radial assembly
- ☐ Bulletin #8 Basic type rings
- ☐ Send me information about the Waldes Grooving Tool.

Name_____

Title_____

Company_____

Business Address_____

City_____ Zone_____ State_____ 5678

—an example of DESIGN LEADERSHIP in

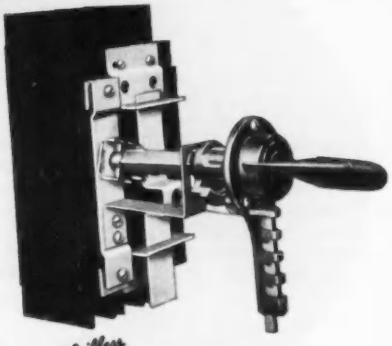
NEW VISIBLE BLADE DISCONNECT SWITCH
(with cabinet cut-away)
showing front-operated mechanism.

NOW—
a Safe, Practical Operating Mechanism for BOTH Switches and Circuit Breakers

CONVENIENT MOUNTING . . . Disconnect device mounts directly on control panel without use of brackets or posts. Coupling rod of proper length engages separate operating handle assembly on door.

SAFE . . . Interlock prevents opening door when disconnect is "ON." Self-aligning handle indicates true position of disconnect. Operating handle can be locked "OFF" with one, two, three or four padlocks of varying sizes. Handle locking mechanism also locks door.

UNIFORM APPEARANCE . . . Same external handle and lock plate design used for either disconnect switch or circuit breaker operating mechanisms.



Cutless
THERMAL-A-MAGNETIC CIRCUIT BREAKER
with operating mechanism . . . maximum flexibility.

Write for Bulletin 2420 F-G. Square D Company,
4041 N. Richards Street, Milwaukee 12, Wisconsin

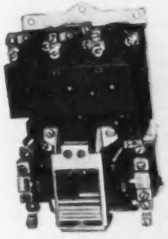
SQUARE D COMPANY

DETROIT · MILWAUKEE · LOS ANGELES

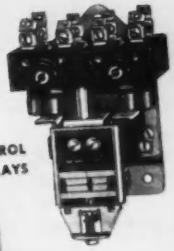
SQUARE D COMPANY CANADA LTD., TORONTO • SQUARE D de MEXICO, S.A., MEXICO CITY, D.F.

MACHINE TOOL CONTROL

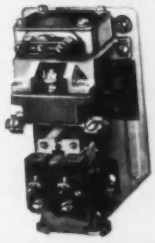
extends SQUARE D's Line of Control Devices designed specifically for Machinery Applications



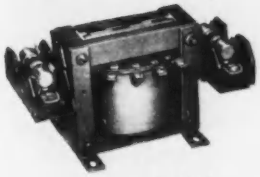
MAGNETIC STARTERS



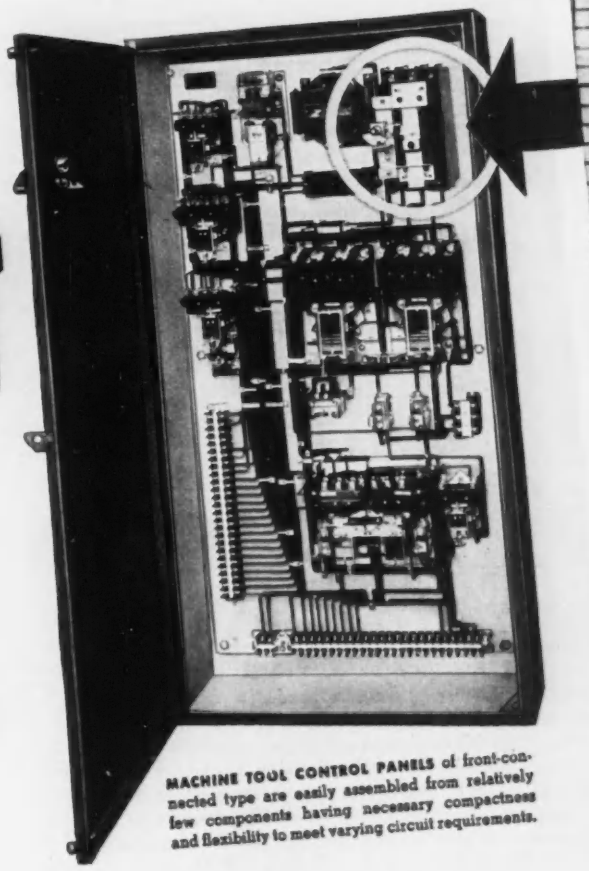
CONTROL RELAYS



PNEUMATIC TIMERS



CONTROL CIRCUIT TRANSFORMERS



MACHINE TOOL CONTROL PANELS of front-connected type are easily assembled from relatively few components having necessary compactness and flexibility to meet varying circuit requirements.

Watch for Square D's Display Coach—Now on Tour

Oil Pump Screens

Gasoline Strainers

Carburetor Filters

Air Cleaners

Cowl Ventilators

Oil Pan Strainers

Radiator Grilles

Brake Lining

from BRAKE LINING TO RADIO GRILLES

Radio Grilles

Automatic Drive Filters

Clutch Housing Ventilators

Floating Type Oil Intakes

Hot Water Heater Grilles

Hot Air Heater Grilles

Crankcase Backing

Clutch Housing Ventilators

Cylinder Block Oil Strainers

wire cloth FOR AUTOMOBILES

America's largest automobile producers carry creative engineering into the production of every part, however small. Reynolds engineers and metallurgists are equally creative in making Reynolds wire cloth to meet even the most exacting of automotive specifications—from metal to mesh and from wire to weave—which contributes its share to the smooth performance, better service and longer life of the modern automobile. If you use wire, perhaps your product may be improved by consulting Reynolds engineers. No obligation.

REYNOLDS WIRE DIVISION
NATIONAL-STANDARD COMPANY
DIXON, ILLINOIS

NS NATIONAL-STANDARD Company NILES, MICHIGAN

HIGHER EFFICIENCY

WITH BENDIX SCINFLEX
ELECTRICAL CONNECTORS

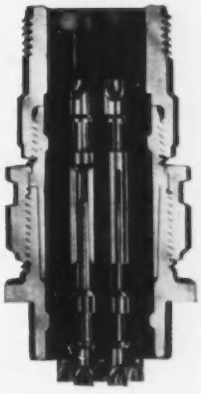
MINIMUM VOLTAGE DROP

PLUS

- Moisture proof
- Pressure Tight
- Radio Quiet
- Single-piece Inserts
- Vibration proof
- Light Weight
- High Insulation Resistance
- Easy Assembly and Disassembly
- Fewer Parts than any other Connector
- No additional solder required

The ability to carry maximum currents with only a minimum voltage drop is an outstanding characteristic of Bendix Scinflex Electrical Connectors. This important feature is only a part of the story of Bendix success in the electrical connector field. The use of Scinflex dielectric material, an exclusive Bendix development of outstanding stability, increases resistance to flash over and creepage. In temperature extremes, from −67°F. to +275°F. performance is remarkable. Dielectric strength is never less than 300 volts per mil. All in all, no other electrical connector combines as many important exclusive features as you will find in Bendix Scinflex connectors. For higher efficiency in your electrical connectors be sure to specify Bendix Scinflex. Our sales department will gladly furnish additional information on request.

PLUS

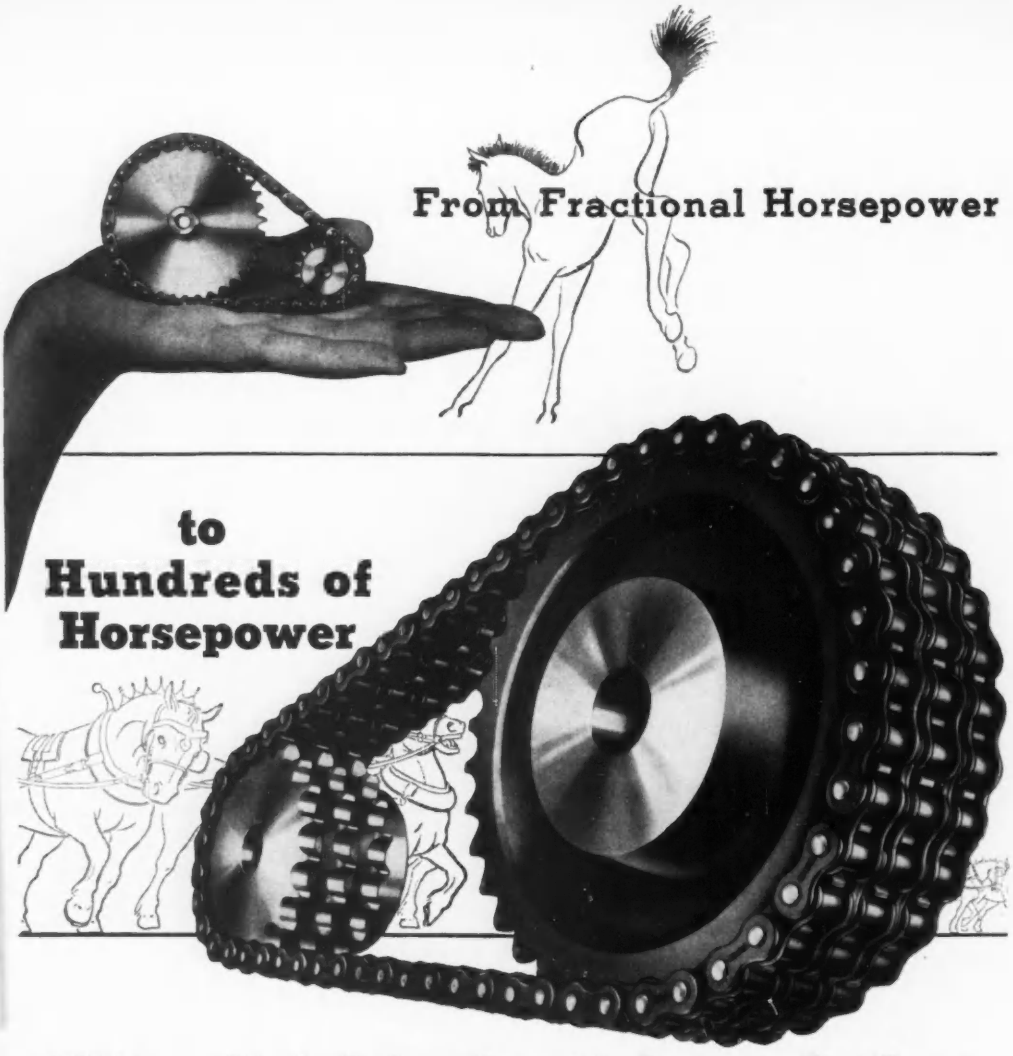


SHELL
High strength aluminum alloy . . . High resistance to corrosion . . . with surface finish.

CONTACTS
High current capacity . . . Low voltage drop.

SCINFLEX ONE-PIECE INSERT
High dielectric strength . . . High insulation resistance.

Bendix



Whitney Chain Drives Simplify Design—Cut Costs

No matter what your drive problem, be it small movie cameras, machine tools or earth movers, you will find a Whitney Chain Drive to fill the application exactly.

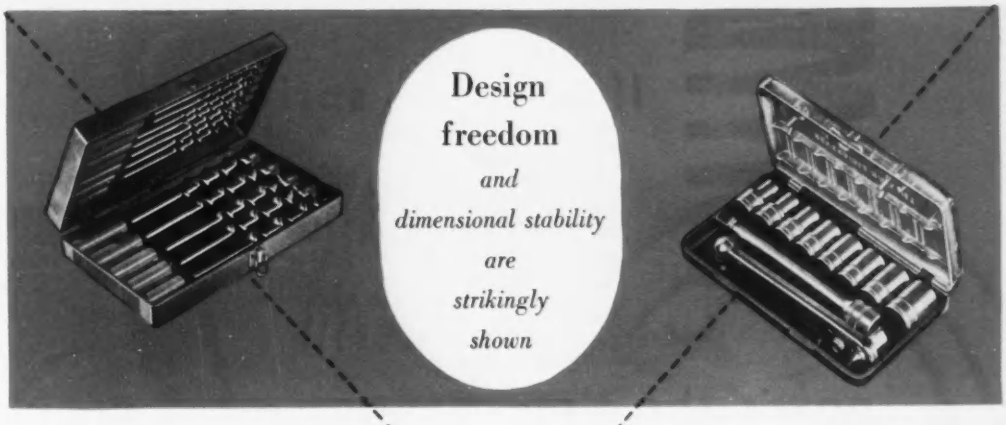
And what's more, these adaptable drives offer opportunities for important cost reductions and improved performance. *For example* — Whitney Chain Drives operate equally well on long or short centers. They will drive single or multiple shafts, provide accurate timing or reversal of direction. Standard attachments, built into the chain, offer still more opportunities for economical application possibilities.

And remember, Whitney Chains . . . *the all-steel drives* . . . deliver *full rated* power, smoothly and dependably. Their positive grip transmits constant, uniform speed. They are easily and quickly installed, reducing costly down time. No removal of shafts or bearings necessary. Alloy steel construction assures maximum service with minimum maintenance.

WHITNEY ENGINEERING SERVICE — In addition to the service facilities of more than 130 Distributors, Whitney maintains a network of 15 Field Engineering Offices, located throughout the country. From the complete line of Roller, Silent and Conveyor chains, Whitney engineers can recommend the proper type of drive for your application . . . the chain drive which will give you the best service at lowest cost. Consult your nearest Whitney field office or write us direct for catalog and complete information.

WHITNEY CHAIN COMPANY

204 Hamilton Street, Hartford 2, Connecticut



in these applications of STYRON

A high quality plastic also used because of its

MOLDABILITY

•

MOISTURE RESISTANCE

•

RESISTANCE TO BREAKAGE

Further evidence of the wide applicability of Styron (Dow polystyrene) to industrial uses is seen in the examples shown. Both the package for the socket wrenches and the container (with the exception of hinges and metal spring devices) for the drill set are made of a high-impact formulation of Styron.

The design freedom and the moldability of this high-quality plastic simplified production problems and reduced production operations. This meant important savings in costs.

Such additional characteristics of Styron as dimensional stability, moisture resistance, ability to withstand rough treatment and its availability in a wide range of formulations and colors are also of interest to engineers and designers.

Styron brand plastics are workable, basic raw materials that are pointing the way to faster and better production, and *lower costs* in a number of great industries. In many packaging applications Styron is releasing vital metals needed elsewhere in the defense effort. Dow's Plastics Technical Service is fully equipped to help you determine the applicability of Styron to *your* manufacturing operation. Write Dow today.

THE DOW CHEMICAL COMPANY
Plastics Department—PL-85
MIDLAND, MICHIGAN

New York • Boston • Philadelphia • Atlanta
Cleveland • Detroit • Chicago • St. Louis • Houston
Los Angeles • San Francisco • Seattle
Dow Chemical of Canada, Limited, Toronto, Canada

The Styron label is the hallmark of quality in plastics goods.

STYRON *brand plastics*

. . . basic raw materials serving basic industries

DOW plastics

If you use springs . . .

now's the time to use our free design service

Here's a chance to help the war effort, cut your costs and improve your product all at the same time.

It's simply this: submit your present or proposed spring design to our skilled spring engineers for analysis. Without the slightest obligation they will check it to see if, 1) performance can be improved, 2) amount of steel can be cut, 3) design can be simplified or, 4) costs can be lowered.

Based on previous experience, we think there's a good chance that our men can offer constructive suggestions that will do one of these four things.

Our engineers are more than designers. They're production men, too. They know all the things that spring machines can and cannot do effectively. They have their fingers on the pulse of the steel wire situation, so they'll try to select the lowest price grade of wire that will do a good job—yet be in reasonably good supply.

To take advantage of this free service, call our nearest office for more information.

AMERICAN STEEL & WIRE COMPANY, GENERAL OFFICES: CLEVELAND, OHIO • COLUMBIA STEEL COMPANY, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
TENNESSEE COAL, IRON & RAILROAD COMPANY, BIRMINGHAM, SOUTHERN DISTRIBUTORS • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS AMERICAN Quality SPRINGS

UNITED STATES STEEL

Whether you want one worm-gear speed reducer or a thousand, a standard drive or a specially designed unit, Cleveland can serve you to your complete satisfaction.

Performance measures value in a Cleveland

FOR nearly 40 years, Cleveland has concentrated on the manufacture of worm-gear drives.

In specializing on a single type of gearing, this Company has emphasized one value above others—dependability—measured by the yardstick of performance on the equipment of its customers.

Thousands of worm-gear drives, made in the earliest years of the Company's operations, are in service today. They do not wear out. They serve in every phase of American industry, drive every type of mechanical equipment where a powerful, trouble-free, right-angle drive is wanted.

For a full showing of the wide variety of sizes and capacities of Cleveland worm-gear drives available, write for new Catalog 201F. The Cleveland Worm and Gear Co., 3279 East 80th St., Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

Standard bearings can cut your costs...

When you want anti-friction performance in your product, consider the possibilities of "Commercial" ball bearings. Schatz "Commercial" ball bearings can economically replace bushings or plain sleeve bearings, and thus improve product performance without adding a price premium. "Commercial" bearings can often substitute for costly precision bearings too, when tolerances aren't tight.

So be sure to investigate the standard line of Schatz "Commercial" ball bearings. This line includes 22 basic types, both ground and unground; some types are available in metric sizes.

The careful manufacture of Schatz "Commercial" ball bearings insures top performance.

"Commercial" bearings are now in heavy demand because of their versatility and wide design possibilities. But Schatz engineers will welcome the chance to help you conquer friction economically. Write for catalog No. 11 today.

Check these Schatz standard types before you specify bearings:

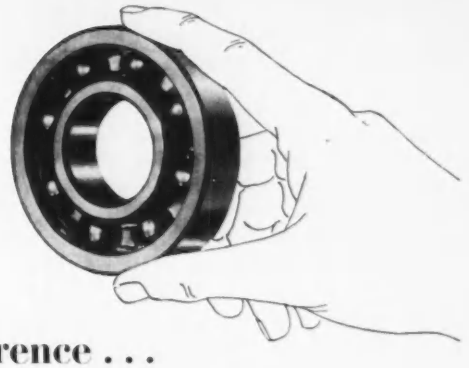
Type A (unground) double row ball bearings
Type A (unground) thrust ball bearings
Type A (unground) flanged ball bearings
Type A (unground) plain dust-proof ball bearings
Type A (unground) flanged set screw ball bearings
Type A (unground) flanged ball bearings with set screws and UU seal; and with Alemite fitting
Plain Type A (unground) set screw ball bearings
Double Row Type A (unground) set screw ball bearings
Type A (unground) ball bearings with set screws and UU seal; and with provision for relubrication
Type B (ground) set screw and plain dust-proof ball bearings; and plain dust-proof ball bearings
Type A (unground) radial-thrust ball bearings
Type B (ground) banded thrust ball bearings
Type ADX (unground) ball bearings
Type A (unground) ball bearings with UU seal
Type AHR (unground) heavy duty ball bearing rollers
Type AA (precise) single row ball bearings; and Type ARX and ARXX (unground) ball bearing rollers
Ball bearings with metric dimensions
Type A (unground) flanged ball bearings with hex bores
Type KR, KRS and KRP ball bearing rollers with hardened tread
Type KRSF ball bearing rollers with hardened tread; and Type KR and KRS double row ball bearings with hardened tread
Unground radial-thrust ball bearings; and Type A (unground) ball bearings with long inner race
Type BHR (ground) extra heavy duty ball bearing rollers

THE SCHATZ MANUFACTURING COMPANY

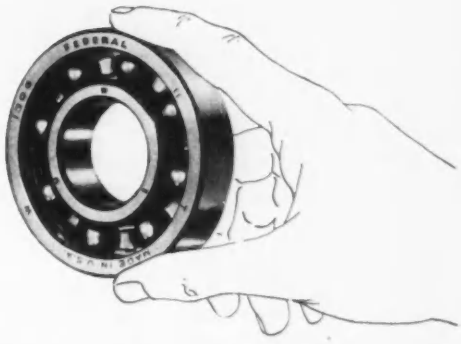
6758 Fairview Avenue · Poughkeepsie, New York

SCHATZ "Commercial" BALL BEARINGS

If You Have a Friction Problem
Let Schatz Engineers Design it Away



Unseen skills make the difference . . .



In materials, dimensions, capacity, one ball bearing *resembles* another. But the difference between an ordinary ball bearing and a Federal ball bearing stems from unseen skills—ranging from research and engineering to special techniques in manufacture and testing.

One of Federal's unseen skills is research. Federal engineers are now in the final stages of a two-year project: a sealing development that makes use of high-strength plastics.

This research will pay in many ways: in better bearing performance; in improved production results. Such study promises more for Federal customers: it is leading Federal engineers into other unusual uses of plastics in ball bearing design.

When you specify a ball bearing, look beyond the obvious measures of materials, dimensions, capacity. *Look for the extra skills that insure better performance.* Federal's 43 years of acceptance in the automotive, tractor, and machinery fields is based on IMAGINATIVE RESEARCH · ADVANCED ENGINEERING · ALERT MANUFACTURING · RIGID QUALITY CONTROL · SUPER-PRECISE TESTING.

THE FEDERAL BEARINGS CO., INC., POUGHKEEPSIE, N. Y.

Makers of Fine Ball Bearings

Quality since 1908

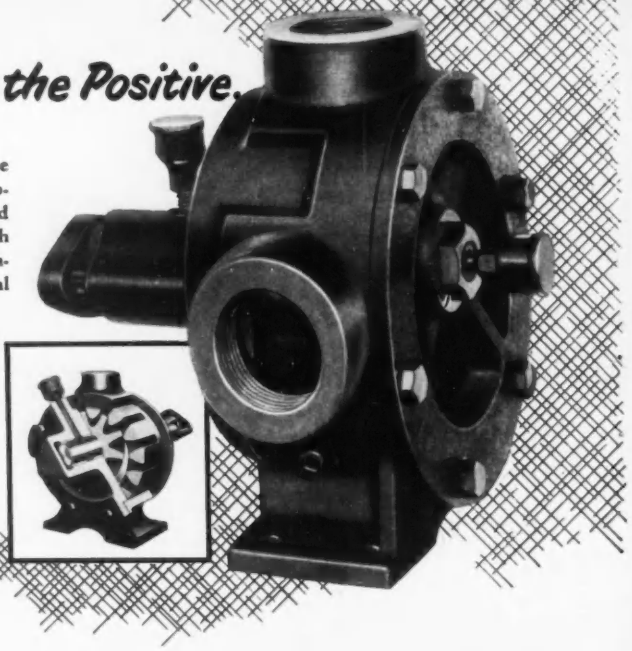
Federal BALL BEARINGS

ONE OF AMERICA'S LEADING BALL BEARING MANUFACTURERS

when the ACCENT is on the Positive.

. . . then the positive pumping of Fairbanks-Morse Rotary Pumps offers the best choice for your equipment. They efficiently handle any free-flowing liquid from gasoline to molasses with exceptionally high efficiency. Non-fluctuating load characteristics minimize shock and vibration . . . assure long, economical service.

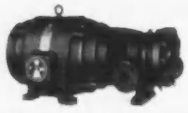
Only TWO parts move in Fairbanks-Morse Rotary Pumps . . . a precision-cut rotor and pinion gear. There are no complicated parts to cause trouble or to require frequent maintenance and adjustment. Capacities range from ⅛ to 5 inches. If your design problems involve positive pumping, choose from the Fairbanks-Morse Rotary Pump line . . . the economical choice.



FAIRBANKS
A NAME WORTH

..when HEADS are up or down

A Fairbanks-Morse Westco turbine-type pump is the efficient answer. The unique design employed in these exceptionally compact pumps permits them to handle widely varying heads with little or no loss of capacity. Maximum capacity is obtained at an operating speed of 1750 r.p.m. when discharging at low pressure, and high pressures are developed at the same speed with little change in capacity. In addition, through the use of a single-stage, multi-vaned impeller, Westco Pumps give you multi-stage performance from a single-stage pump. Westco Pumps are widely used as integral parts of machines, units or systems. Capacities from 1 to 200 g.p.m. Check them for your equipment.



Built-together Centrifugals

Other FAIRBANKS-MORSE Pumps Include

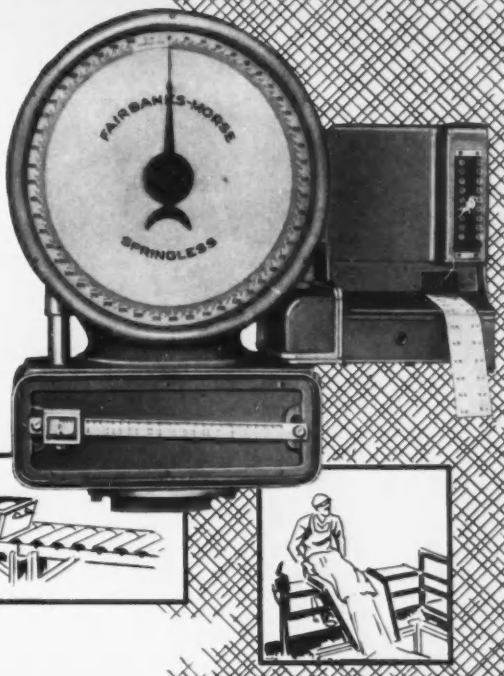
Side-Suction Centrifugals

Single and Two-Stage Centrifugals

when it's a problem of CONTROL

. . . consider the advantages of control by weight! Fairbanks-Morse Printomatic Weighers with electronic attachments accurately control production and processing operations. Materials handling operations, conveyor systems, processing and batching operations can be accurately controlled by these precision instruments. They can open and close valves controlling material flows to predetermined quantities. Templets can be used to preserve formula secrets when compounding mixes.

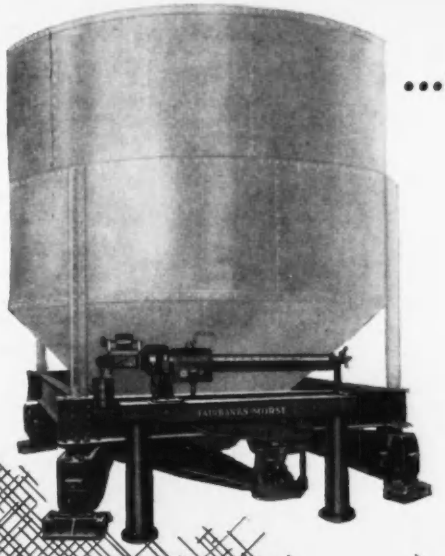
In addition, accurate records of materials can be kept since the Printomatic will furnish printed records of operations. The human element and chance for error are eliminated. Check your Fairbanks-Morse weighing expert on the advantages Printomatic offers you.



-MORSE

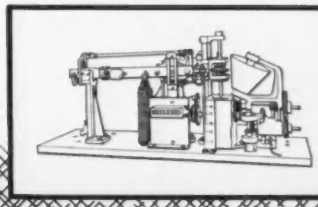
REMEMBERING

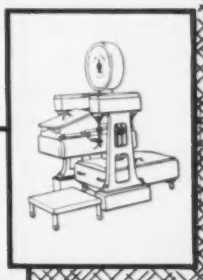
See Next Page for
FAIRBANKS-MORSE
Sales Centers



...when it's a problem in weight

. . . the easy answer is in the complete Fairbanks-Morse scale line. Beam scales or dials, belt conveyor scales, aggregate weighing scales, proportioning and batching scales, truck scales, furnace charging scales, you'll find them all and more. An important point—Fairbanks-Morse Scales *or component scale parts* can be supplied to fit right into your equipment for weight or control operations. Your Fairbanks-Morse weighing expert will be happy to work with you on any scale problem.





MOST Advantages for MOST Motor Applications

STANDARD DRIP-PROOF MOTORS FOR YOUR PROTECTION

Practically every motor needs protection—from flying chips, falling particles, dripping liquids, and the like. Also, by far the majority of motors used are of the polyphase, squirrel cage type.

These requirements are met to a unique degree by this series of Fairbanks-Morse motors—with built-in protection and superior electrical and mechanical design that account for their popularity throughout industry.

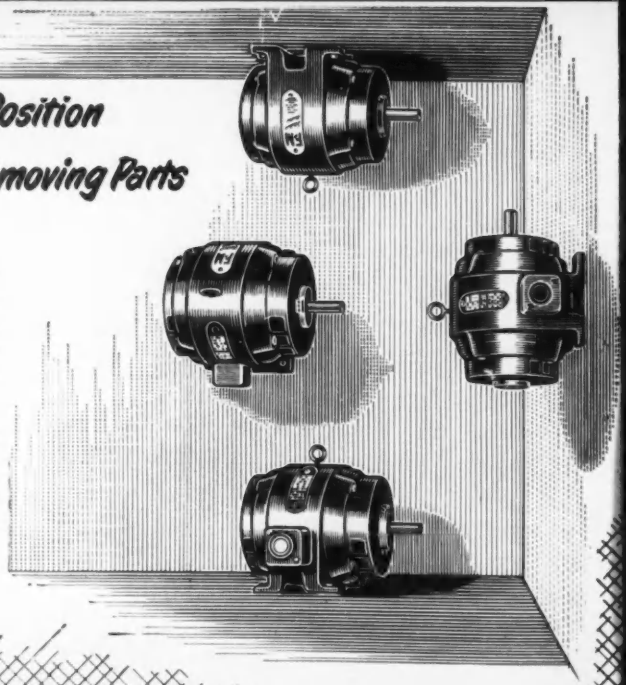
Whether your motor application problems involve driving pumps, machine tools, compressors, elevators, fans—or any of an infinite number of other applications—Fairbanks-Morse Standard Drip-proof Motors deserve your early investigation. Call your nearest Fairbanks-Morse Sales and Service center.

FAIRBANKS

A NAME WORTH

PROTECTION.. *in any Position*

SAFETY.. *no Exposed moving Parts*



Mount these motors anywhere—even on the ceiling or walls. Bearing arms have four bolts spaced 90° apart, enabling the bearing brackets to be adjusted to assure maximum protection. Motor can be mounted vertically without any changes in bearing construction.

There is complete safety for the operator. Fingers can even be placed in vents, for it is not possible to contact fans due to the protective shield. Smooth, streamlined external contour makes the motor easy to keep clean, easier to maintain.

Cross Flow Ventilation...Copper Spun Rotor

...OTHER UNIQUE FEATURES

Cross Flow Ventilation is an exclusive Fairbanks-Morse design that eliminates hot spots, prolongs the life of the stator installation.

Copperspun Rotor: a truly one-piece indestructible copper winding that withstands higher temperatures, has high electrical and thermal conductivity, better dynamic balance.

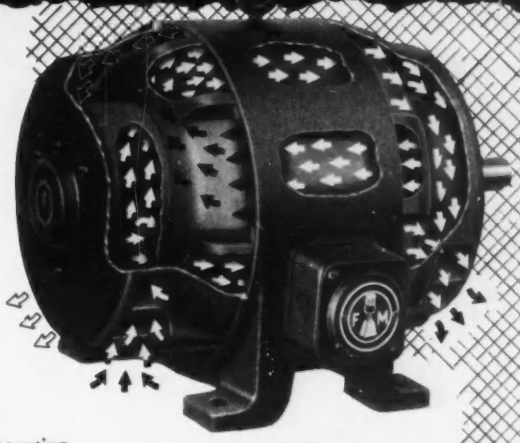
Rugged Frame Construction: Protection in any mounting position.

General purpose continuous duty: rated 40° C. and designed to carry 115% load continuously without injurious heating (1.15% service factor).

High efficiency, high power factor, good starting and accelerating torques.

Unique conduit box provides alternate assembly: either recessed, flush with frame or conventional external mounting.

Mounting dimensions conforming to NEMA standards.



Arrows show double flow of air that keeps motors running cool!

-MORSE

REMEMBERING

THESE ARE YOUR FAIRBANKS-MORSE SALES CENTERS

ATLANTA 3, GEORGIA
760 Lee St., S. W.
AMhurst 7701

BALTIMORE 18, MD.
659 E. 25th St.
BElmont 5258

BIRMINGHAM 1, ALA.
626 N. Ninth St. Zone 4
3-6546

BOSTON 10, MASS.
178 Atlantic Avenue
LAfayette 3-3600

BUFFALO 3, N. Y.
33 Franklin St.
Lincoln 4210

CHARLOTTE 2, N. C.
Liberty Life Bldg.
Room 605
6-2893

CHICAGO 5, ILLINOIS
1550 S. State St.
HArrison 7-7100

CINCINNATI 2, OHIO
49 Central Avenue
MAin 3010

CLEVELAND 14, OHIO
3000 W. 117th St.
CLearwater 1-3300

COLUMBUS 8, OHIO
1034 Goodale Blvd.
WAlnut 8581

DALLAS 2, TEXAS
1713 N. Market Street
CEntral 4347

DENVER 2, COLO.
1500 17th Street
TAbor 6241

DES MOINES 17, IOWA
2017 Dean Avenue
6-1189

DETROIT 13, MICHIGAN
11110 East Warren Ave.
VAlley 1-7100

DULUTH 2, MINN.
Board of Trade Bldg.
2-7538

HOUSTON 13, TEXAS
5521 Navigation Blvd.
WAyside 2159—(LD 506)

INDIANAPOLIS 2, IND.
1499 N. Harding St.
FRanklin 3684
ATlantic 3092

JACKSONVILLE 6, FLA.
930 East Adams St.
5-6473

KANSAS CITY 7, MO.
1300 Liberty Street
Victor 6474

LOS ANGELES 11, CALIF.
4535 S. Soto Street
JEfferson 8151

LOUISVILLE 8, KY.
2008 So. Brook St.
CAlhoun 1469

MEMPHIS 7, TENN.
676 Jefferson Ave.
5-1614

MILWAUKEE 3, WIS.
404 N. Plankinton
DAly 8-0180

MINNEAPOLIS 15, MINN.
417 S. Fourth Street
MAin 4353

NEW ORLEANS 13, LA.
1000 St. Charles Ave.
RAymond 3115

NEW YORK 4, N. Y.
80 Broad St.
HAnover 2-7470

OMAHA 8, NEBRASKA
902 Harney St.
ATlantic 3122

PHILADELPHIA 8, PA.
401 N. Broad St.
WA 2-4100

PITTSBURGH 24, PA.
4301 Main Street
SChenley 1-3123

PORTLAND 14, OREGON
105 S. E. Taylor St.
EAst 0131

PROVIDENCE 3, R. I.
187 Pine Street
GAspee 1-1531

ST. LOUIS 2, MO.
217 South Eighth St.
CHestnut 7483

ST. PAUL 1, MINN.
220-26 E. Fifth Street
GArfield 4335

SALT LAKE CITY 1, UTAH
153 W. Second South St.
3-2108 & 3-5139

SAN FRANCISCO 7, CALIF.
630 Third Street
EXbrook 2-5855

SEATTLE 99, WASH.
Salmon Bay Terminal
ALden 6600

STUTTGART, ARK.
403 South Main St.
185

TULSA 3, OKLA.
1335 Hunt Bldg.
3-8231

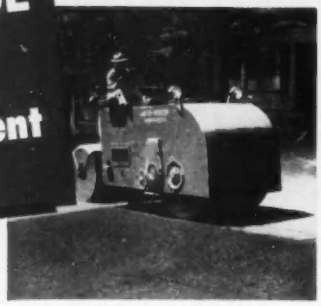
WASHINGTON 5, D. C.
1000 Vermont Ave., N. W.
District 6694

FAIRBANKS-MORSE de MEXICO S. A.
Balderas 146, Mexico 1, D. F. Mexico
10 06 74 y 10 09 58

Export Division:
NEW YORK 4, N. Y.
80 Broad Street—HAnover 2-7470

EXCEPTIONAL PERFORMANCE on mobile equipment

Austin-Western "99-H" Power Grader



Austin-Western Tandem Roller

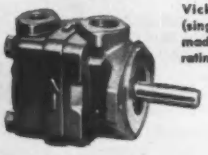
Austin-Western Model "40" Motor Sweeper

. . . that's why

Austin-Western *uses*

VICKERS VANE TYPE PUMPS

Here are some of the reasons for the outstanding performance of the Vickers mobile equipment pump shown below . . . reasons that influenced its selection as the source of hydraulic power for Austin-Western road machinery.



Vickers Balanced Vane Pumps (single) for mobile machinery are made in 10 sizes having delivery ratings from 3.2 to 52 gpm @ 1000 psi and 1800 rpm. Higher pressures and/or speeds also possible. Several mountings and four optional positions of pressure outlet connection. Also available in double pump combinations.

1. Compact, high-efficiency design with many choices of pump size and mounting arrangement SAVES SPACE and also provides INSTALLATION SIMPLICITY.

2. Pump does not load up until engine is up to speed, for EASY COLD WEATHER STARTING.

3. All running clearances automatically maintained as pump wears; PERFORMANCE DOES NOT DROP OFF WITH WEAR.

4. Exclusive hydraulically balanced design neutralizes oil pressure loads on bearings, providing LONG LIFE WITH NO ADJUSTMENTS.

5. Rugged construction makes Vickers mobile equipment pumps TOUGH.

For further information get in touch with the nearest Application Engineering office or write to Detroit for Catalog M-5100.

VICKERS Incorporated *DIVISION OF THE SPERRY CORPORATION*

1454 OAKMAN BLVD. • DETROIT 32, MICH.

Application Engineering Offices: ATLANTA • CHICAGO (Metropolitan) CINCINNATI • CLEVELAND • DETROIT • HOUSTON • LOS ANGELES (Metropolitan) NEW YORK (Metropolitan) • PHILADELPHIA • PITTSBURGH • ROCHESTER • ROCKFORD ST. LOUIS • SEATTLE • TULSA • WASHINGTON • WORCESTER

Ask for NEW CATALOG M-5100

4545

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

IDEAS *in the making*

ARALDITE* *Bonding, Casting, Coating Resins and* **ARDUX*** *Bonding Resins developed by Ciba Research are simplifying manufacturing methods, improving product efficiency, and opening new fields of product development. Some important new and typical "in use" examples are shown and described here.*

PERMANENT PROTECTION

against destructive action of fatty acids on aluminum walls lengthens service life of new cream whipping dispenser.

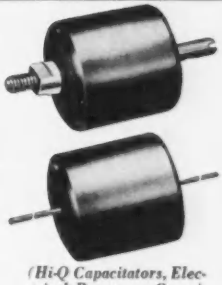
(Kidde Manufacturing Company)

A big problem simply remedied at low cost. The Araldite coating resin used here sets at room temperature, is completely tasteless, odorless and inert, and is characterized by excellent wetting and covering power on metals.

Editor's Note: Araldite coating resins are also being successfully applied as liners for cans and collapsible tubes.

IMPROVED EFFICIENCY

for high voltage capacitators.



(Hi-Q Capacitators, Electrical Reactance Corp.)

Piercing pressure of dielectric material increased greatly by jacketing procedure using an ARALDITE Casting Resin that provides high dielectric strength, arc and humidity resistance, affinity for metals. Transformers weighing many pounds have been potted in Araldite Casting Resins.

Editor's Note: Among other fields of Araldite Casting Resin use . . . valves and fittings of exceptional corrosion resistance and dimensional stability. Sets without evolution of volatile materials. Requires no pressure.

DURABLY BONDS

metals, (ferrous and nonferrous) to rubber, (natural and synthetic) . . . also wood, thermo-setting plastics, to themselves or to each other.

ARDUX Resins provide much sought properties . . . overcome stress failure and effects of shock loading . . . give high strength at high temperatures.

(Above) Ardux Resin bonds brake linings to brake shoes and clutch plates. Eliminates rivets.

(Right) Rubber tubing bonded with Ardux Resin to aluminum alloy capping strip. (The De Havilland Aircraft Co., Ltd.)

IDEA GENERATORS!

Newest ARALDITE and ARDUX Resins Technical Bulletins are now ready, giving complete technical data on physical properties and recommended procedures. Profusely illustrated with application photographs and diagrams.

Send for your copies . . .

(OR WRITE IN DETAIL ON YOUR LETTERHEAD)

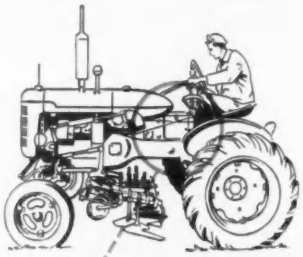
Ciba *Plastics*

★ BONDING ★ CASTING ★ COATING RESINS

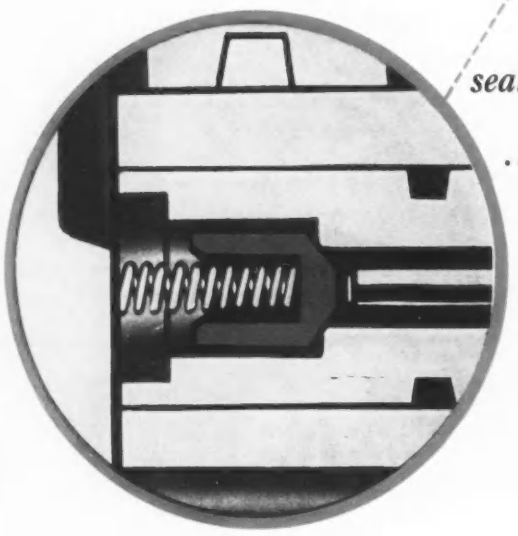
*Reg. U.S. Pat. Off.

CIBA COMPANY INC., PLASTICS DIVISION P.E.
627 Greenwich St., New York 14, N. Y.
(In Canada: Ciba Co. Ltd., Ciba Bldg., Montreal)
Please send me Ciba Plastics Technical Bulletins for
BONDING ☐ CASTING ☐ COATING ☐

*Name*_____
*Company*_____ *Title*_____
*Address*_____



Leak-proof check valve of resilient Du Pont nylon



Two nylon check valves, like the one above, stop the flow of oil from either side of the hydraulic power piston. Thus, they keep the plow or other implement locked in position at the proper level.

seats perfectly without machining,

...gives long, trouble-free service

For the hydraulic Touch-Control lift on "Farmall" tractors, International Harvester engineers needed a perfectly leak-proof check valve. This vital part traps oil on both sides of the power piston, thus holding the implement rigidly in the selected position. By molding the valve of Du Pont nylon, many advantages over the former steel part have been obtained.

Because of its resiliency, the nylon plastic part provides a tight seal, even if there are slight imperfections in the mating surface . . . does not become worn or grooved after repeated contact with the bushing. Too, the nylon part is made in one piece by the rapid mass-production injection-molding process . . . needs no costly machining to provide a smooth seat within close tolerances.

Du Pont nylon withstands the high temperature of the oil in the system (up to 200° F.), and remains dimensionally stable, chemically inert. Two years of trouble-free service in "Farmall" tractors have demonstrated the value of nylon valve seats.

Perhaps nylon's strength, resiliency and other valuable properties can help solve a problem for you. For further information on nylon and other Du Pont plastics, write:

E. I. du Pont de Nemours & Company (Inc.)
Polychemicals Department, District Offices:
350 Fifth Avenue, New York 1, New York
7 S. Dearborn St., Chicago 3, Illinois
845 E. 60th St., Los Angeles 1, California

Nylon part molded by Formold Plastics, Inc., Chicago.

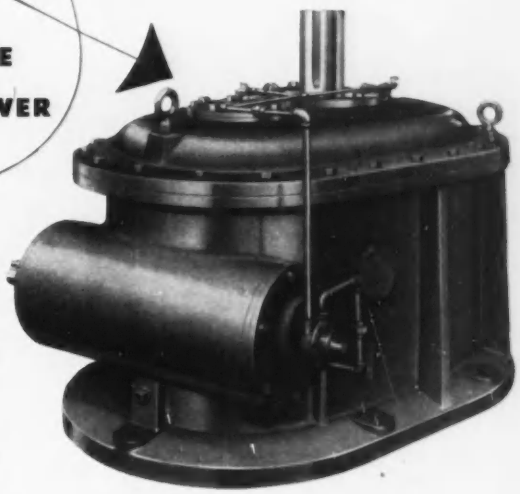
DU PONT

BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

Polychemicals
DEPARTMENT
PLASTICS • CHEMICALS

have you a drive problem?

A FOOTE BROS.
WORM-HELICAL DRIVE
MAY PROVIDE THE ANSWER



● Rugged strength, the ability to stand up under punishing loads, the highest possible efficiency — these are characteristics of Foote Bros. Worm-Helical Drives.

Input shafts are horizontal, output shafts vertical, up or down — making these units ideal for use in chemical plants, pulp mills or wherever materials must be agitated or mixed.

Foote Bros. Worm-Helical Drives are available in ratios from approximately 25 up to 285 to 1—capacities up to 128 h.p. See your Foote Bros. representative or mail the coupon for information.

FOOTE BROS. GEAR AND MACHINE CORPORATION
4545 S. Western Boulevard • Chicago 9, Illinois

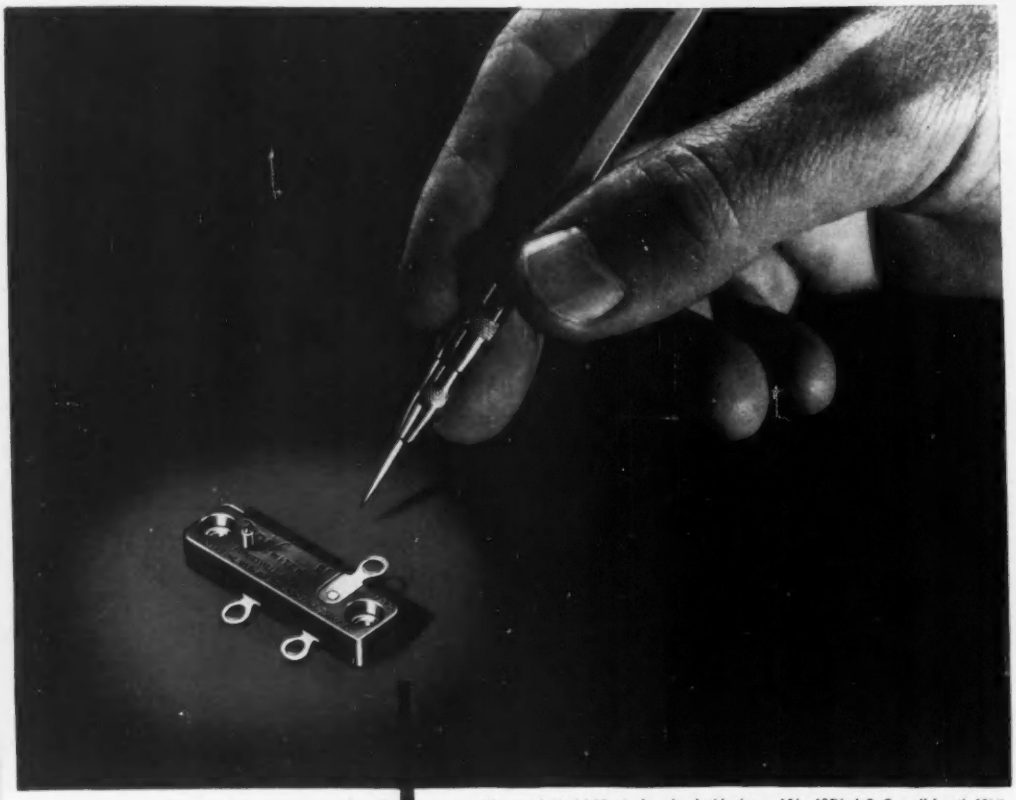
Whatever your requirements in power transmission, you will find exactly the drive best suited to your needs in the complete Foote Bros. line of enclosed gear drives and gearmotors. Check the coupon indicating the drive in which you are interested.

FOOTE BROS.
Better Power Transmission Through Better Gears

Foote Bros. Gear and Machine Corporation
Dept. W., 4545 S. Western Boulevard, Chicago 9, Illinois
Please send bulletins on drives checked below.

- ☐ WORM-HELICAL DRIVES
- ☐ LINE-O-POWER STRAIGHT LINE DRIVES
- ☐ MAXIPOWER HELICAL GEAR DRIVES
- ☐ HYGRADE WORM GEAR DRIVES
- ☐ FOOTE BROS.-LOUIS ALLIS GEARMOTORS

Name .....
Company ..... *Position* .....
Address .....
City ..... *Zone* ..... *State* .....



Illustrated: Model BP, single-pole, double-throw, 15A., 125V. A.C. Overall length 1⅛".

The only miniature snap switch

. . . where size and high rating come to terms with cost

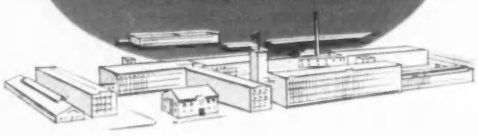
More and more, today's new products need the design forethought that assures quality performance *without increase in price*. And that's just where TYNISWITCH can help.

TYNISWITCH fills the need for high load switching in small spaces at lower cost than any other dependable miniature snap switch. Of special importance for many products is the specialized engineering service which develops new models for individual application requirements. This service offers an economical solution to your most difficult switching problems. Conventional circuit arrangements are available in a variety of standard stock models.

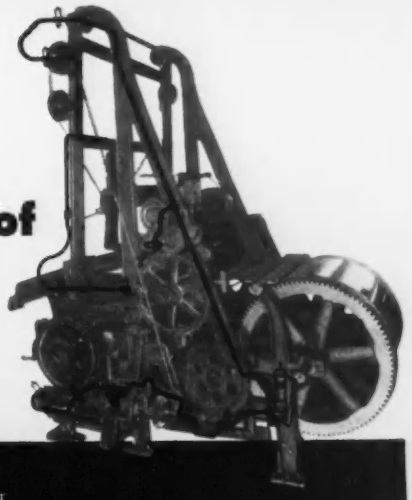
Investigate the advantages of TYNISWITCH. They add up to dependability and value unsurpassed in today's market. Write for details. TYNISWITCH Division, The Sessions Clock Company, 101 East Main St., Forestville, Conn.

Tyni SWITCH

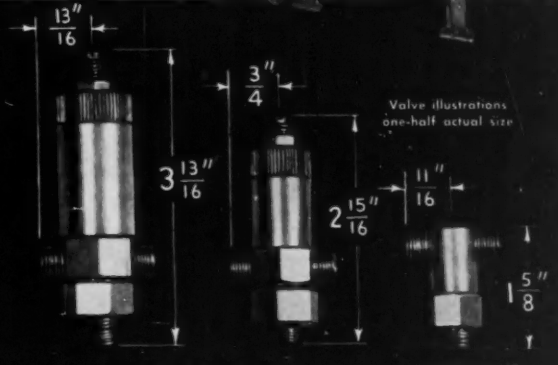
A DIVISION OF THE SESSIONS CLOCK COMPANY, FORESTVILLE, CONNECTICUT



It's simple to design this "insurance" of greater production into your machines



ALEMITE TYPE I Accumeter SYSTEM



Virtually any machine that must be lubricated with fluid oils or light greases can have the protection of automatic *mechanized* lubrication. Alemite's Type I Accumeter System is the answer! So simple, so compact is this versatile *single line* system, that you can incorporate it in your designs with remarkable ease.

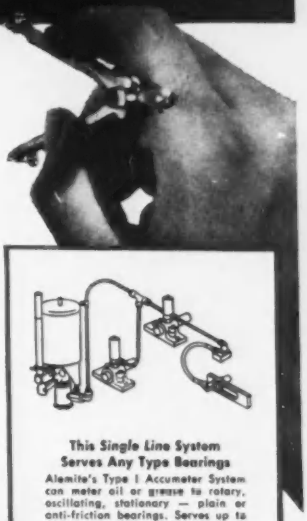
The Alemite Type I Accumeter Automatic Lubrication System consists of a lubricant pump, a distribution system of tubing, and *force-feed* valves mounted on or near individual bearings.

From one central point, it safely, surely lubricates all the bearings on a machine . . . automatically . . . while production goes on. Increases output by eliminating shutdown for lubrication! Ends the risk of lubrication errors or neglect by your customers! Reduces maintenance and repair costs, prolongs machine's life.

Alemite Accumeter Systems meter lubricants with a sustained accuracy unmatched by any other method. In fact, tests show *no variation* in the amount of lubricant discharged to bearings . . . even after 73,312 lubrication cycles—equivalent to 122 years of twice-a-day service!

What's more, Alemite Accumeter Automatic Lubrication is not merely "one-shot" lubrication. It is *continuous* between cycles. That's because Alemite's exclusive "accumulating" feature *prolongs* the discharge of lubricant to bearings.

Alemite Accumeter Automatic Lubrication is adaptable to machines of every type and size. There are three separate systems, to cover your full range of needs. Write now for Form 22-189, a free 16 page brochure giving full data. And for specific application recommendations, include description of machines you are presently working on. Alemite, Dept. T-111, 1850 Diversey Parkway, Chicago 14, Illinois.



This *Single Line* System Serves Any Type Bearings

Alemite's Type I Accumeter System can meter oil or grease to rotary, oscillating, stationary — plain or anti-friction bearings. Serves up to 400 bearings. Valves for any bearing capacity. FIXED or ADJUSTABLE output.

ALEMITE

A PRODUCT OF SW STEWART WARNER

ACCUMETER AUTOMATIC LUBRICATION
1850 Diversey Parkway, Chicago 14, Illinois

When you use Shelby Seamless

the basic shape is already made

You can save time, money and steel—and make a better automotive product—when you use Shelby Seamless Tubing for hollow cylindrical parts. Compared to solid bar stock or forgings, this high quality seamless tubing requires much less cutting or boring. Since fewer operations are required, man and machine hours are less, rejects are fewer, production of all automotive parts is speeded up.

The products shown here are typical of this more efficient method of manufacturing. Some of these parts are quite complex, but each was made from Shelby Seamless Tubing, faster and at lower cost than identical parts machined from solid bar stock. In several cases production has been doubled or tripled—costs savings have run as high as 50 percent—rejects have been reduced to zero.

Shelby Seamless Steel Tubing is pierced from a solid billet of quality steel. As a result, there is no longitudinal weld to weaken the tube. This process gives you the strongest, most dependable tubular steel section that money can buy.

Shelby Seamless Steel Tubing is manufactured in a complete range of diameters, wall thicknesses and analyses to meet every need. When you plan for future automotive applications, remember Shelby Seamless for its ability to increase strength, reduce weight and cut your production costs.

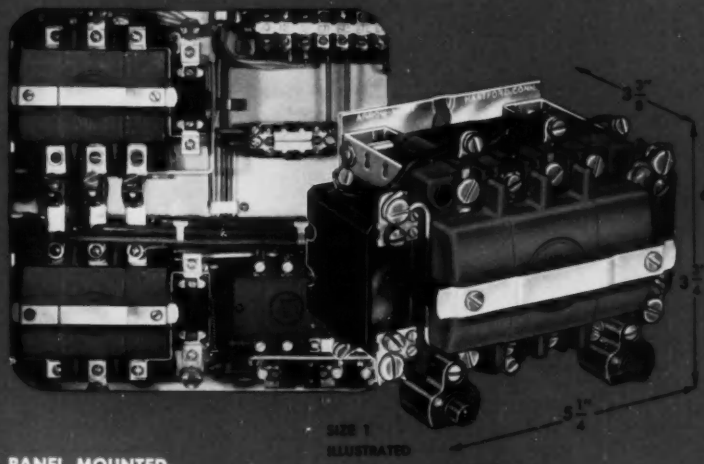
NATIONAL TUBE COMPANY, PITTSBURGH, PA.
(Tubing Specialties Division)
COLUMBIA STEEL COMPANY, SAN FRANCISCO
PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

Shelby Seamless Steel Tubing

UNITED STATES STEEL

BRING OUT **BUILT-IN PERFORMANCE** OF MOTORS AND MACHINERY



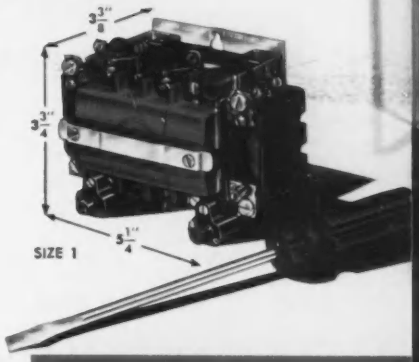
PANEL MOUNTED

SURFACE MOUNTED

NEW TYPE "RA" ARROW AH HART MAGNETIC STARTERS

JUST 1/2 THE SPACE

PLUS EASY, LOW COST MAINTENANCE



Arrow-Hart Type "RA" Magnetic Starters and Contactors are designed with easy, low cost maintenance in mind. Because the A-H starter occupies only ½ the space of conventional starters, there's more working room in the box, less space required for control panel layout. Wiring is easier, because it's straight-thru all the way. All terminals and contacts are easy to reach. Terminals are front wired. Line and load wires connect at opposite ends. The switch itself is easily installed with three mounting screws. Contact inspection or replacement is readily made by loosening two hood retaining screws. This ease of wiring and servicing is made possible by the revolutionary "RA" (Right Angle) Balanced Mechanism exclusive in Arrow-Hart starters.

BUY WITH CONFIDENCE *PROFIT BY PERFORMANCE*

THE ARROW-HART & HEGEMAN ELECTRIC COMPANY, HARTFORD, CONN., U. S. A.

ARROW AH HART

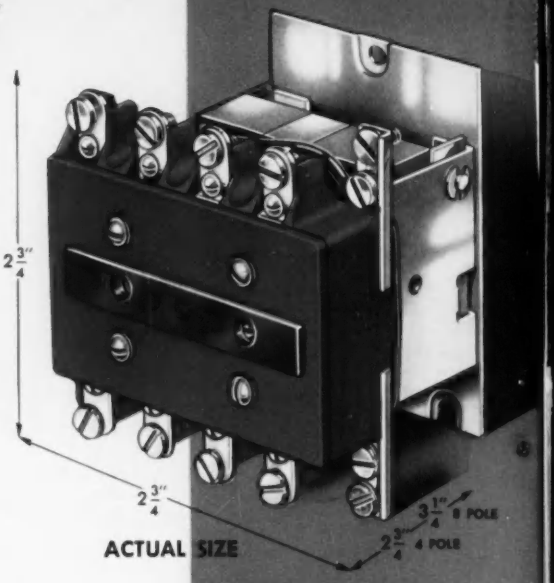
INCHES SMALLER...

EVERY INCH A CHAMPION!

NEW AH SIZE 00

Type "CRA" CONTACTOR

The revolutionary new Arrow-Hart Size 00 Type "CRA" Contactor measures just 2¾" x 2¾" — cuts inches off any other contactor on the market — yet is every inch a champion! Take the design: from Arrow-Hart's exclusive new "RA" (Right Angle) mechanism — the same which enabled A-H engineers to build the compact control package described on the preceding page — to the 00's ***automatic*** positive contact pressure control, this ingenious multi-pole convertible contactor results in big savings of space, work, time, money; assures you unparalleled performance throughout its long life.



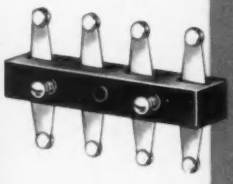
ACTUAL SIZE

ONLY 4 BASIC SECTIONS

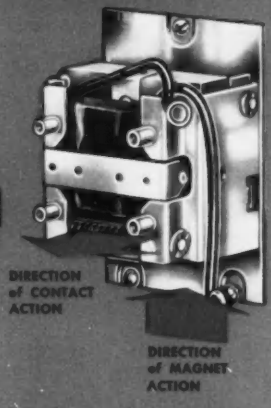
1 COVER PLATE

2 STATIONARY CONTACT BASE

3 MOVABLE CONTACT UNIT



4 FRAME with COIL-MAGNET MECHANISM ASSEMBLY



Here are just a few of its host of extra features: **Right Angle mechanism, reducing size by as much as ¾ • Ultra-functional design • Fewer components — reduced handling • No-twist no-rock frame • Compactness within own framework • Unit stability and rigidity • Foolproof, guided assembly throughout • Contacts operate in vertical position • Self-aligning contact action • Unusual ability to handle a multiplicity of circuits • Movable contact carrier • Enclosed contact chambers • All wiring in line and straight-thru • Mat-finished cover plate for terminal markings • and many more.**

Get all the facts about the A-H Size 00 Type "CRA" Contactor, available in 2, 3 and 4 pole types. Send for Engineering Data Folder.

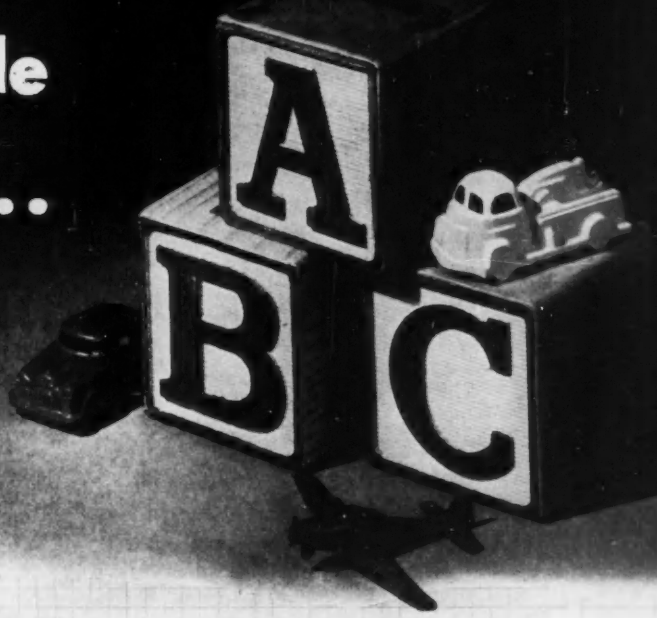
ARROW·HART

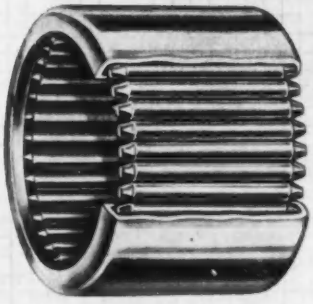
THE ARROW-HART & HEGEMAN ELECTRIC COMPANY
103 HAWTHORN STREET
HARTFORD 6, CONNECTICUT, U.S.A.

Branch Warehouses: BOSTON, CHICAGO, CLEVELAND, CINCINNATI, DALLAS, DENVER, DETROIT, LOS ANGELES, NEW YORK, PHILADELPHIA, SAN FRANCISCO, SYRACUSE. In Canada: ARROW-HART & HEGEMAN (CANADA) LTD., MT. DENNIS, TORONTO.

PRINTED IN U.S.A.

simple as . . .





Torrington Needle Bearings:

A. Simplify design. A hardened shaft to serve as the inner race, a simple bore housing and a Needle Bearing are all you need for efficient anti-friction performance.

B. Simplify machining. No complex housings or shoulders are required—just a straight bore machined to proper dimensions.

C. Simplify assembly. A fast arbor press operation seats the bearing by press fit . . . no spacers or retainers are needed to hold Needle Bearings in position.

Torrington Needle Bearings may well be the answer to *your* design and production problems. Our engineers will be glad to help.

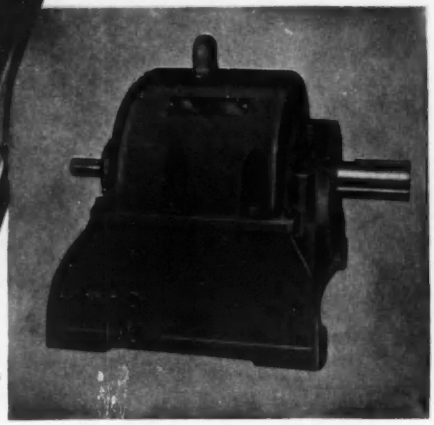
THE TORRINGTON COMPANY

Torrington, Conn. South Bend 21, Ind.

District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON *NEEDLE* BEARINGS

NEEDLE • SPHERICAL ROLLER • TAPERED ROLLER • STRAIGHT ROLLER • BALL • NEEDLE ROLLERS



NOW!

New Space Savings

with speed reducers

A new series of concentric shaft type speed reducers has been added to the Westinghouse line of Geared Drives. This construction features straight-line mounting of speed reducer and prime mover, requiring a minimum of floor space.

Designated as "Type DB" speed reducers, these units are designed to economically transmit the inherently high speeds and efficiencies of electric motors. Power transmission efficiency averages 96%. Eight unit sizes are available over a range of 1 to 100 hp. Twelve standard gear ratios ranging from 6:25:1 to 58:3:1 are provided.

Included in these new speed reducers are the quality features common to all Westinghouse Geared Drives:

Single Helical Gears accurately hobbed on precision machines. BPT Taper Hardening produces tough, impact-resisting teeth.

Split Case Construction permits easy accessibility. Strong, tight case heavily ribbed to provide extra strength.

Ample Lubrication by simple, positive splash system for both gearing and bearings.

For more information, write for DB-3700-1 SR. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-07299

YOU CAN BE SURE.. IF IT'S

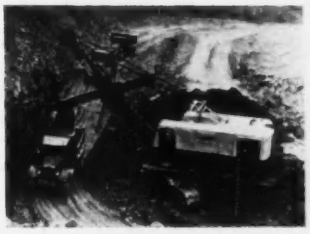
Westinghouse

GEARED DRIVES

Reprints from this or other Logbook pages are available for your files. Request them from our Redwood City, California office

Oil seals installed to permit periodic flushing of bearings in large hoist drum assembly

A simple and practical solution to an unusual combination of sealing problems is found in the hoist drum assembly of the Marion Type 93-M Power Shovel.



Design of the hoist drum assembly requires oil sealing to retain lubricant around four widely separated main bearings. However, the sealing must be such as to easily permit periodic flushing of the entire housing area by grease under pressure.

Other design features also affect the sealing problem. Shaft diameters are large—approximately 10". The shafts are reversible; they operate at variable speeds, and there are many abrupt starts and stops. There are the run-out inducing tendencies of hoist pulls exceeding 32.5 tons. Frequently, there are severe external dust conditions.

An effective and economic solution of the problem is the use of two pairs of National 50,000 series seals. These are steel-encased, spring-loaded units with leather sealing members.

The outer pair of the large, heavy-duty seals is installed at (A) in the assembly. Sealing members face inward to retain lubricant around the bearings and prevent leakage onto the drum brake assembly. These sealing members also exclude dust and other foreign abrasives from the bearings and housing.

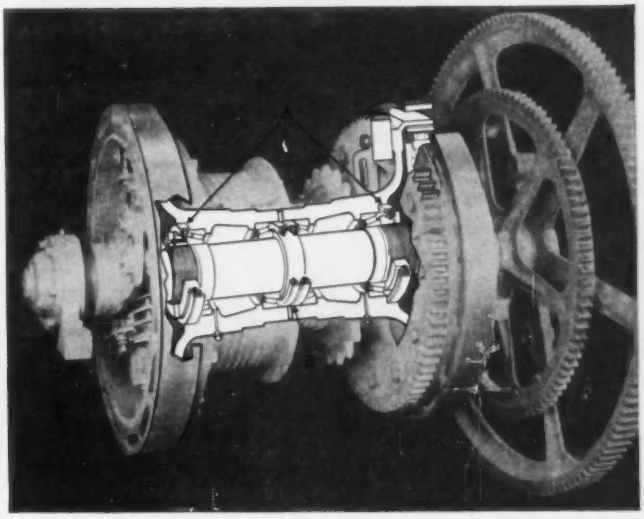


Fig. 1—Hoist drum assembly

Fig. 2—National 50,000 series seal

At (B), an identical pair of National 50,000 series seals are installed with sealing lips facing outward. Correct loading of the tension springs insures retention of lubricant during operation, permits lubricant flushing at a controlled point during periodic greasing operations, and excludes dust, mud, etc.

National Oil Seals used in the Marion 93-M assembly are standard designs, as are other National seals used elsewhere in this equipment. In many cases, widely varied sealing problems can be solved quickly and economically through use of standard designs. In other cases, special designs and tools are needed. In either event, National Oil Seal engineers can call on 25 years of sealing experience to help you. For complete information, write or call the nearest National office.

"Let Your Decision be Based on Precision"

NATIONAL OIL AND FLUID SEALS

NATIONAL MOTOR BEARING CO., INC.

General Offices: Redwood City, California
Plants: Redwood City, Calif.; Downey (Los Angeles County), Calif.; Van Wert, Ohio

2281

CALL IN A NATIONAL FIELD ENGINEER

BUFFALO, N. Y. . . . . *Room 1124, Prudential Bldg., Mohawk 9222*
CHICAGO, ILL. . . . . *Room 2014 Field Building, Central 6-5663*
CLEVELAND, OHIO . *210 Heights Rockefeller Bldg., Yellowstone 2-2720*
DALLAS, TEXAS . . . *30½ Highland Park Village, Justin 8-5453*
DETROIT, MICH. . . . . *726 Lothrop Avenue, Trinity 1-6363*
DOWNEY (Los Angeles Co.), CALIF. . *11634 Patten Rd., Topaz 2-8166*
WICHITA, KANSAS . . . . . *519 South Broadway, Wichita 2-6971*
MILWAUKEE, WIS. . . . *647 West Virginia Street, Broadway 1-3234*
NEW YORK CITY, N. Y. . . *122 East 42nd Street, Lexington 2-8260*
PHILADELPHIA, PA. . . . *401 North Broad Street, Bell-Walnut 2-6997*
REDWOOD CITY, CALIF. . . *Broadway and National, Emerson 6-3861*
WEST SPRINGFIELD, MASS. . . *1025 Elm Street, Springfield 2-1881*
SYRACUSE, N. Y. . . . . *P.O. Box 1224, Baldwinsville 662*

NEW!
RUBBER
RESILIENCE
NEVER BEFORE EQUALLED
WITH A LEATHER PACKING
HOUGHTON LINE OF
PACKINGS INCLUDES:
VIM LEATHER PACKINGS—Cups, Cones, "U", "V"—flat washers, discs and gaskets—for oil, air, water or gas pressures—in hydraulic or pneumatic equipment, pumps, valves, etc.
VIX-SYN SYNTHETIC RUBBER PACKINGS—homogeneous and fabricated packings, gaskets and adaptors, also "O" rings and VIM Leather back-up washers designed for use with them.

Vim IMPREGNATED LEATHER PACKINGS

HOUGHTON

VIM #1243

RUBBER IMPREGNATED LEATHER PACKINGS

COMBINING THE STRENGTH AND ENDURANCE OF LEATHER WITH THE RESILIENCE AND RESISTANCE TO TEMPERATURE WHICH RUBBER POSSESSES!

All the good features you found in Houghton Leather Packings—plus the extra advantages our new development gives you—are now offered in standard packing sizes.

By an ingenious method devised by Houghton engineers, durable leather is thoroughly impregnated with tough, "springy" synthetic rubber. The result is a packing with the outstanding benefits both leather and rubber provide.

By specifying Houghton VIM No. 1243 Packings you are guaranteed the low-friction coefficient that quality leather assures. You benefit from leather's longer life. You obtain the high resistance to abrasion, extrusion, and cold vulcanizing which have made Houghton's leather packings so widely used.

Now, in addition, you get the perfect seal which non-porous rubber provides. Being impregnated through and through with lively rubber, these new leather packings are made exceptionally pliable. Their design permits preloading and makes installation easy.

Houghton VIM No. 1243 Leather Packings—already in use for several years—are performance-proved!

We're ready now to furnish this new rubber-impregnated packing in "V" and Cup Types on rated orders, in standard sizes only. Order through your Houghton Man or from E. F. Houghton & Co., Philadelphia 33, Pa. We'll gladly send further information promptly on request.

VIM and VIX-SYN PACKINGS

. . . products of

E. F. HOUGHTON & CO.

PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

Ready to give you on-the-job service . . .

Do You Know?

YOU CAN CHANGE SPEEDS
IN A RATIO OF 7200:1 IN A SPACE OF ABOUT 2 CU. IN. WITH A **TELECHRON** SEALED, SELF-OILING GEAR TRAIN... IF YOUR OUTPUT SHAFT LOAD DOES NOT EXCEED .375 POUND INCHES?

216,000 TO 1

SPECIAL GEAR TRAINS
CAN BE MADE BY **TELECHRON INC.** IN A WIDE CHOICE OF SPEED RATIOS UP TO 216,000:1?

ALL TELECHRON SPUR GEARS ARE HOBBED...
NOT STAMPED... FOR TRUER, QUIETER OPERATION AND LONGER LIFE?

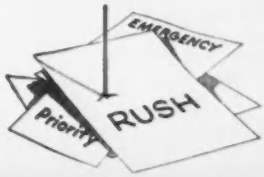
YOU CAN BREAK BOTTLENECKS
ON YOUR DEFENSE CONTRACTS BY CALLING IN **TELECHRON INC.** NEW BROCHURE "PRECISION ON THE PRODUCTION LINE" GIVES A QUICK PICTURE OF PERSONNEL CAPABILITIES AND MASS PRODUCTION FACILITIES. WRITE FOR YOUR COPY TODAY.

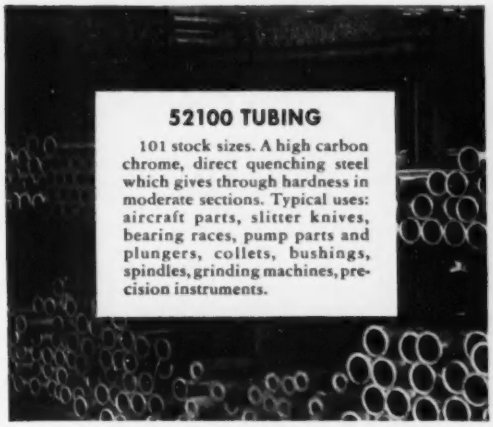
BY RETURN MAIL,
YOU CAN GET DATA AND ESTIMATED QUANTITY PRICES ON **TELECHRON** GEAR TRAINS IN STANDARD SPEED-CHANGE RATIOS RANGING FROM 7200:1 TO 25:1. WRITE FOR THE FACTS TODAY.
TELECHRON DEPARTMENT,
GENERAL ELECTRIC COMPANY, 111 UNION ST.,
ASHLAND, MASS.

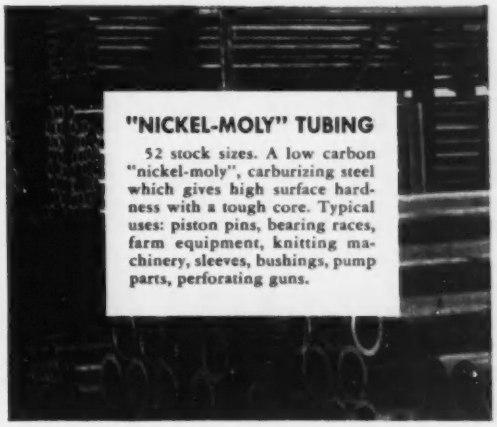
Telechron®

ALL TELECHRON TIMING MOTORS ARE INSTANTLY...CONSTANTLY SYNCHRONOUS

Tight steel supply got you in a pinch?




52100 TUBING
101 stock sizes. A high carbon chrome, direct quenching steel which gives through hardness in moderate sections. Typical uses: aircraft parts, slitter knives, bearing races, pump parts and plungers, collets, bushings, spindles, grinding machines, precision instruments.


"NICKEL-MOLY" TUBING
52 stock sizes. A low carbon "nickel-moly", carburizing steel which gives high surface hardness with a tough core. Typical uses: piston pins, bearing races, farm equipment, knitting machinery, sleeves, bushings, pump parts, perforating guns.

These two TIMKEN® steels will do 90% of your hollow parts jobs

and are available now in warehouse lots!

IF rush jobs find you short of steel tubing, get in touch with the Timken Company. The two Timken® steels described above—52100 tubing and "Nickel-moly" tubing—will do 9 out of 10 of your hollow parts jobs. And we guarantee shipment of warehouse lots within 24 hours after receipt of order.

We maintain a mill stock of 101 sizes of 52100 tubing —from 1" to 10½" O.D. This analysis is through-hardening in moderate sections. It can be heat treated to file hardness and tempered back to any point you want. There are 52 stock sizes of "Nickel-moly" tubing—from 1⅛" to 10¼" O.D. With heat treatment, it develops exceptional shock absorbing qualities.

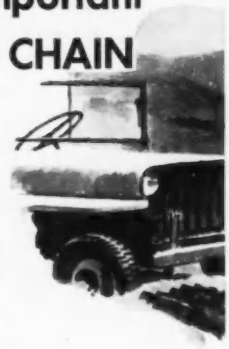
Uniformity in every shipment is assured by the Timken Company's complete, rigid quality control from melting through final inspection. For the current mill stock list, write on your company letterhead to The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

Specialists in alloy steel—including hot rolled and cold finished alloy steel bars—a complete range of stainless, graphitic and standard tool analyses—and alloy and stainless seamless steel tubing

They can't phone your plant

In Your Military Product it's Doubly Important to Leash "Straying Parts" with BEAD CHAIN



When a householder or industrial worker mislays an essential part of your product, he may suffer inconvenience or minor hardship. But, loss of some important small part of military equipment may mean that men are lost, too.

Positive leashing of straying parts is one of the most common jobs for Bead Chain. And, nothing can equal it as a parts retainer! The non-kinking, free-swiveling action of a Bead Chain retainer assures full freedom in using the part or tool it secures. It is small, light, attractive . . . yet strong enough to hold under abusive strains.

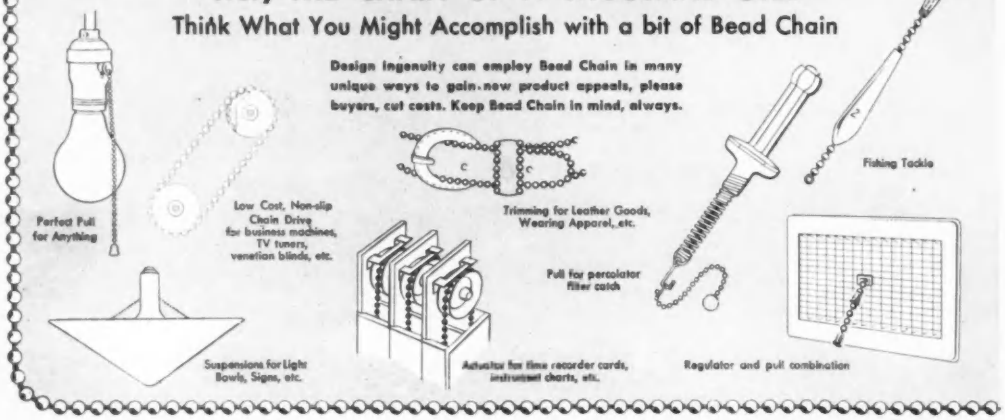
Check your product now. Leash any part that may stray. It costs only a penny or two, as a rule, to add a Bead Chain retainer that's worth dollars as a trouble-saver for your customers. Check your plant, too, for opportunities to tie straying items like tools to the point of use and eliminate work delays.

Any Product Wins Buyer Approval When Vital Parts are Secured

Truly THE CHAIN OF A THOUSAND USES

Think What You Might Accomplish with a bit of Bead Chain

Design ingenuity can employ Bead Chain in many unique ways to gain new product appeals, please buyers, cut costs. Keep Bead Chain in mind, always.


Perfect Pull for Anything
Low Cost, Non-slip Chain Drive for business machines, TV tuners, venetian blinds, etc.
Trimming for Leather Goods, Wearing Apparel, etc.
Fishing Tackle
Pull for percolator filter catch
Suspensions for Light Bowls, Signs, etc.
Actuator for time recorder cards, instrument charts, etc.
Regulator and pull combination

if a part gets lost

Specify "BEAD CHAIN"...Get 4 Plus Values

1. Dependable Quality and Delivery... ... The Bead Chain Mfg. Co. is the world's largest producer, with exclusive methods and equipment that assure uniform quality and lowest costs.

2. Unmatched Application Service ... ... The "know-how" acquired in applying Bead Chain to meet the requirements of thousands of uses is yours to command.

3. Widest Selection of Chain and Attachments ... You get just what you want from the world's largest selection of chain sizes, styles, metals and finishes ... and attachments for fitting the chain to your particular need.

4. Money-Saving Chain Assembly Service ... Many manufacturers save money and bother by using this unique service. Special equipment and experienced workers enable The Bead Chain Mfg. Co. to provide made-to-your-order assemblies ready to install.

Typical Military Uses for Retainers

Canteen Cap — Courtesy Wyandotte Chain Co.

Aircraft Access Plate

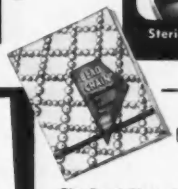
Ship Alarm Hammer

Sterilizer Lamp Cap

B® BEAD CHAIN®

SAVE...Let us make your Tiny Parts like these

Get Our quote ... ses for yourself ... if you use solid or tubular pin-like parts and variations of bushings, sizes up to ¼" dia. and to 1½" length. With our unique MULTI-SWAGE METHOD, developed to produce Bead Chain, we make a big saving by greatly increasing production rate and eliminating scrap. For facts, write a note on coupon—"Send MULTI-SWAGE Catalog, too."



--IT'S NEW!--

I want the new Bead Chain Catalog – Data Folder

The Bead Chain Manufacturing Co.
92 Mountain Grove St., Bridgeport, Conn.

Name, Title .....

Company .....

Address .....

.....

CONTROLS FOR MILITARY AND CIVILIAN PRODUCTS-

KLIXON *Thermo-Snap* Temperature Controls

Klixon Thermo-Snap Temperature Controls are widely used in both military and commercial applications in products ranging from tanks and aircraft to radio and electronic equipment, sterilizers and household appliances.

Actuated by the snap-acting Spencer Disc, these controls open the circuit with a quick, clean break . . . close the circuit with fast solid make. Their accurate, sensitive operation is best able to withstand shocks, vibration, altitude or motion.

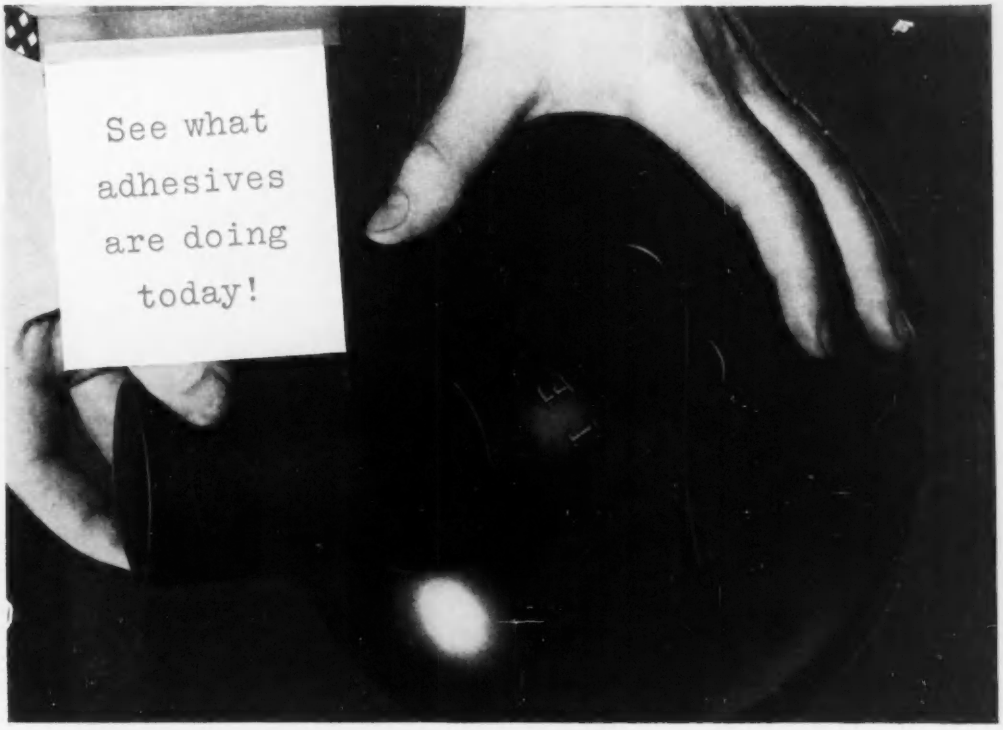
Klixon Thermo-Snap Controls are available in many types and ratings including hermetically sealed units. Our engineers will gladly help you with your temperature control problems. Write for their help and information, today.

KLIXON

SPENCER THERMOSTAT
Division of Metals & Controls Corp.
911 FOREST ST., ATTLEBORO, MASS.

KLIXON MOTOR PROTECTORS PREVENT MOTOR BURNOUTS

To keep motors operating longer, specify and use motors with built-in Klixon Protectors. Built-in by the motor manufacturers, they prevent motor burnouts by cutting "off" the power should the motor become dangerously overheated. When it cools to safety, the protector snaps the power "on" automatically if the "automatic reset" is specified . . . or by pushing the red button when the "manual reset" type is used.



"Plugging" for more strikes

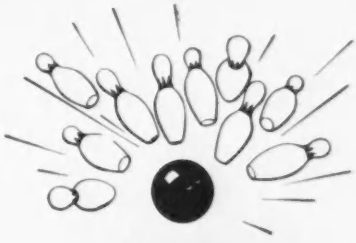
To bowlers, the "plug" is a familiar sight. When finger holes begin to wear, or must be changed to fit a certain grip, it is necessary to bore new holes in the ball—and plug the old ones.

One prominent manufacturer had been installing plugs with pitch, a process that required a curing time of four or five days, and produced an imperfect bond. 3M developed an adhesive which not only gave a better bond, but speeded drying time by *400%*. And when you consider the conditions the adhesive met—tremendous resistance to impact, temperature changes, shrinking and aging—you realize the extensive engineering that goes into the product.

It is this same ability to engineer each compound to a specific use that makes *all* 3M adhesives, coatings and sealers *tops in performance!*

See what adhesives can do for you . . .

Call the 3M office in your city and investigate, with the help of a laboratory-trained field engineer, the potential that adhesives hold for you. And for more information and a valuable 32-page booklet, write 3M. Dept. 411. in Detroit.



3M COMPANY

OVER 1,000 BASIC

ADHESIVES · COATINGS · SEALERS

ADHESIVES AND COATINGS DIVISION • MINNESOTA MINING AND MANUFACTURING COMPANY
411 PIQUETTE AVE., DETROIT 2, MICH
GENERAL OFFICES: ST. PAUL 6, MINN. • EXPORT SALES: 270 PARK AVE., NEW YORK 17, N.Y.
MINNESOTA MINING & MANUFACTURING CO. OF CANADA LTD., LONDON, CANADA

A Lot of Dependability in a Small Package

Thousands of industrial firms recognize the Cuno AUTO-KLEAN disc-type strainer as an indication of *protection* on lube and hydraulic systems.

They know the machine builder has provided the best means of keeping fluids *clean* . . . when he has installed the AUTO-KLEAN as standard equipment.

They appreciate, too, the ease with which the AUTO-KLEAN works. A turn of a handle—periodically by hand or continuously by automatic means—is all that is necessary to keep the strainer *itself* clean. This is done without stopping flow. And there's nothing to replace or renew.

They also know that the AUTO-KLEAN is *guaranteed* to remove 100% of the solids larger than specified*. . . with minimum pressure drop.

The Favorite of Designers

The Cuno AUTO-KLEAN solves other problems *right on the board.*

It's compact. A single unit handling full flow (from a few to more than 4000 gpm) occupies no more space than the usual partial-flow type.

You can build it in—or mount it externally. Inlet and outlet can be in any position. You can install it on low pressure or gravity feed or suction with no loss of efficiency.

And you can depend upon it lasting as long as the equipment on which it is installed because it is all-metal and non-collapsible and can be made of a wide range of materials for various fluids, viscosities, temperatures and solids to be handled.

*Available spacings from .0035 in. to .062 in.

Cuno Engineering Corporation
Dept. 301A, South Vine St., Meriden, Conn.
Please send information on Cuno AUTO-KLEAN
for .....
Name .....
Company .....
Address .....
City ..... Zone .... State ....
Please attach to business letterhead

You Can Clean This Fluid Strainer Without Stopping the Flow

Cuno **AUTO-KLEAN** is the *only* fluid strainer with "comb-action cleaning" which permits it to work uninterruptedly. Dirt accumulations are dislodged *while* the straining goes on. This can be done automatically. *Guaranteed* to remove 100% of all solids larger than specified.

CUNO

Fluid Conditioning

Removes More Sizes of Solids from More Kinds of Fluids

Strain fuels, lubricants, process fluids, etc.—AUTO-KLEAN
Filter fuels, lubricants, process fluids, etc.—MICRO-KLEAN
Clean raw water, recirculating water, etc.—FLO-KLEAN

black topper

Smartly named is this Bituminous Distributor, known as the "Black Topper." Smart, too, is the manufacturer's choice of American Flexible Metal Hose for conveying the hot road-binding tars and asphalts from distributor to hand-spray gun, from supply tank to distributor and from tank car to supply tank. This is a good example of the "careful attention to engineering detail" which the E. D. Etnyre & Co., Oregon, Ill., says is largely responsible for the success of its "Black Topper."

good design is simple... with flexible connectors

The men who designed these products solved with ease connector problems that might have been difficult without *flexible* connectors. There's a great advantage in giving serious consideration to the use of American Flexible Metal Hose and Tubing right in the beginning—when you're drawing up plans for your product.

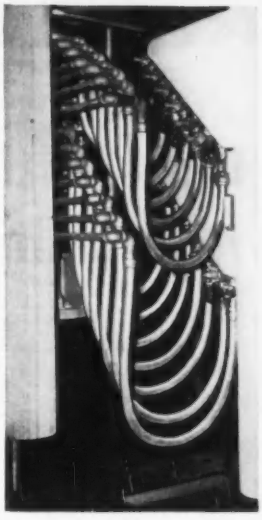
If your product involves conveying fluids, gases or semisolids even under severe conditions of temperature, pressure or corrosion—especially where movement is involved—consider the simple solution American Flexible Metal Connectors offer. For protecting wiring, tubing and flexible shafts, for absorbing vibration, there's a style for your need. You will find the full details in Bulletins SS-50 and CC-300. Write for them today. The American Brass Company, American Metal Hose Branch, Waterbury 20, Connecticut. In Canada: The Canadian Fairbanks-Morse Co., Ltd. 31241

wherever connectors must move...

ANACONDA

American

FLEXIBLE METAL HOSE AND TUBING

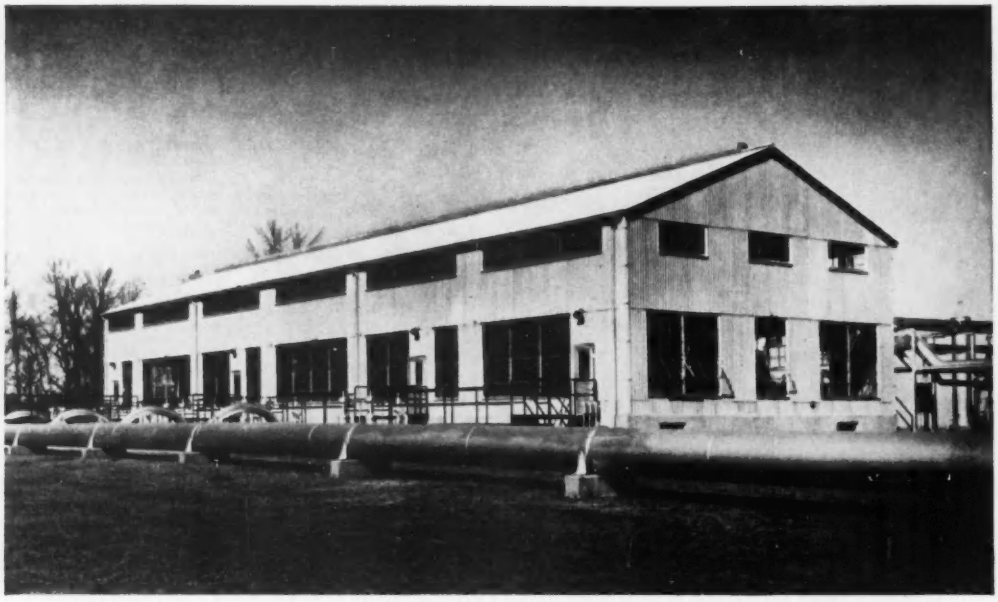


platen press

This multiple-platen high-pressure press for bonding phenol and phenol-melamine surfaced laminates uses 56 lengths of American Seamless Bronze Flexible Tubing. These carry 360°F water at a pressure of 200 p.s.i. to the fourteen platens of this press, used by National Plastic Products Co. of Odenton, Md. Despite this pressure, these flexible connectors stay tight and maintenance is no problem.

thermocouple

One of the most popular uses for American Flexible Metal Hose is its extensive employment as a protective casing or sheath. In this thermocouple, made by the Illinois Testing Laboratories and specially shaped for portable use, $\frac{7}{32}$" I.D. American Stainless Steel Flexible Tubing houses lead wires connecting the instrument with the thermocouple proper.



Pipe ranging from 24 in. to 30 in. in diameter was fabricated from ½ in. and ¾ in. Mayari R plate, for use in the Transcontinental Gas Pipe Line that connects the gas fields of West Texas with New York. This pipe was used at 12 different pumping stations along the line. Fish Engineering Corporation and Fish Constructors, Incorporated, handled the design, engineering and construction of the line.

Mayari R Pipe Withstands Vibration in World's Longest Gas Line

Because pumping equipment generates a certain amount of vibration, the builders of the 1840-mile Transcontinental Gas Pipe Line used Mayari R steel pipe at the pumping stations. The large-diameter pipe fabricated from this low-alloy, high-strength steel connects directly with the pumps, and extends some distance in both directions from the stations.

Mayari R was selected because its mechanical properties are substantially higher than those of carbon steel. It has a yield point, for instance, of 50,000 psi minimum, and an endurance limit of 50,000 psi. These properties permit the use of considerably higher working stresses.

It also has better resistance to impact and to atmospheric corrosion than carbon steel, which means longer service life.

And there are no fabricating problems with Mayari R; it can be cut, formed, punched and machined like carbon steel. The same equipment is used, although slight allowances may be required to offset the higher properties of this grade. Mayari R can also be welded by all of the usual methods.

Now widely used in structures, vehicles, and construction equipment as well as in many consumer products, Mayari R is making design improvements possible at low cost. To get more information on this material and its applications write or phone our nearest sales office for Catalog 259.

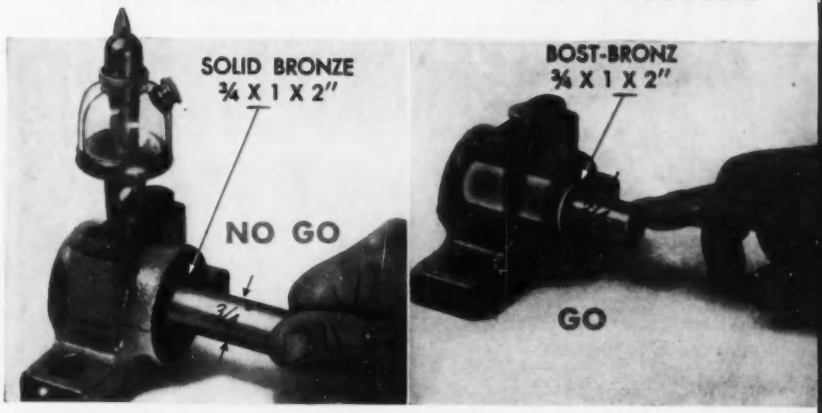
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

Mayari R *makes it lighter... stronger... longer lasting*

$3.32 SOLID BRONZE vs. SAME SIZE $.90 BOST-BRONZ®



COST OF BEARING	$ .87	COST OF BEARING	$ .90
REAMING	.70	REAMING NOT NECESSARY	.00
GROOVING	1.40	GROOVING NOT NECESSARY	.00
DRILLING	.35	DRILLING NOT NECESSARY	.00
COST OF MACHINING	2.45	COST OF MACHINING	.00
NO GO	$3.32	GO	$.90

1. BOST-BRONZ requires .... NO REAMING
   NO GROOVING
   NO DRILLING

2. BOST-BRONZ *gives better service* and *lasts longer*, whether loads are heavy or light, static or shock.

3. BOST-BRONZ is *cleaner* — no oil drip or waste, no openings for grit, lint or dirt.

IN STOCK 589 SIZES

Cylindrical Flanged } BEARINGS • BARS • PLATE

Write for a FREE Sample!

BOSTON GEAR WORKS

71 HAYWARD ST., QUINCY 71, MASS.

BOSTON Gear's STOCKS ARE Here

ERIE, OHIO
ALBANY, NEW YORK
ALLENTOWN, PENNSYLVANIA
ATLANTA, GEORGIA
BALTIMORE, MARYLAND
BIRMINGHAM, ALABAMA
BOISE, IDAHO
BOSTON, MASSACHUSETTS
BRIDGEPORT, CONNECTICUT
BROOKLYN, NEW YORK
BUFFALO, NEW YORK
CHARLOTTE, NORTH CAROLINA
CHATTANOOGA, TENNESSEE
CHICAGO, ILLINOIS
CINCINNATI, OHIO
CLEVELAND, OHIO
COLUMBUS, OHIO
DALLAS, TEXAS
DAYTON, OHIO
DENVER, COLORADO
DES MOINES, IOWA
DETROIT, MICHIGAN
GRAND RAPIDS, MICHIGAN
GREENSBORO, NORTH CAROLINA
HAMILTON, ONTARIO
HARTFORD, CONNECTICUT
HOUSTON, TEXAS
INDIANAPOLIS, INDIANA
JACKSONVILLE, FLORIDA
KANSAS CITY, MISSOURI
KNOXVILLE, TENNESSEE
LANCASTER, PENNSYLVANIA
LONDON, ONTARIO
LONG ISLAND CITY, NEW YORK
LOS ANGELES, CALIFORNIA
LOUISVILLE, KENTUCKY
MEMPHIS, TENNESSEE
MIAMI, FLORIDA
MILWAUKEE, WISCONSIN
MINNEAPOLIS, MINNESOTA
MONTREAL, QUEBEC
NASHVILLE, TENNESSEE
NEWARK, NEW JERSEY
NEW ORLEANS, LOUISIANA
NEW YORK, NEW YORK
OAKLAND, CALIFORNIA
PHILADELPHIA, PENNSYLVANIA
PITTSBURGH, PENNSYLVANIA
PORTLAND, OREGON
PROVIDENCE, RHODE ISLAND
QUEBEC, QUEBEC
QUINCY, MASSACHUSETTS
RICHMOND, VIRGINIA
ROCHESTER, NEW YORK
ST. LOUIS, MISSOURI
SAN JOSE, CALIFORNIA
SAN FRANCISCO, CALIFORNIA
SEATTLE, WASHINGTON
SPRINGFIELD, MASSACHUSETTS
SYRACUSE, NEW YORK
TAMPA, FLORIDA
TOLEDO, OHIO
TORONTO, ONTARIO
TRENTON, NEW JERSEY
VANCOUVER, B. C.
WATERBURY, CONNECTICUT
WILKES-BARRE, PENNSYLVANIA
WINSTON-SALEM, NORTH CAROLINA
WORCESTER, MASSACHUSETTS

Simuplate FOR GOLD, BRASS AND BRONZE COATINGS

With shortages and restrictions on metals, you can keep your production line moving with SIMUPLATE—a practical new organic coating. When applied over properly prepared surfaces it develops the bright lustre of either polished gold, brass or bronze. It's passed many exhaustive tests for wearability under all types of conditions.

Let us tell you more about SIMUPLATE and show you how easily you can get striking effects with combinations of SIMUPLATE finishes. Write or call today.

Superior on-the-job performance and quality have linked Industrial

Finishes by STANDARD to Industry since 1870.

Finishes to meet U. S. Government specifications.

STANDARD VARNISH WORKS
a division of
STANDARD-TOCH CHEMICALS, Inc.

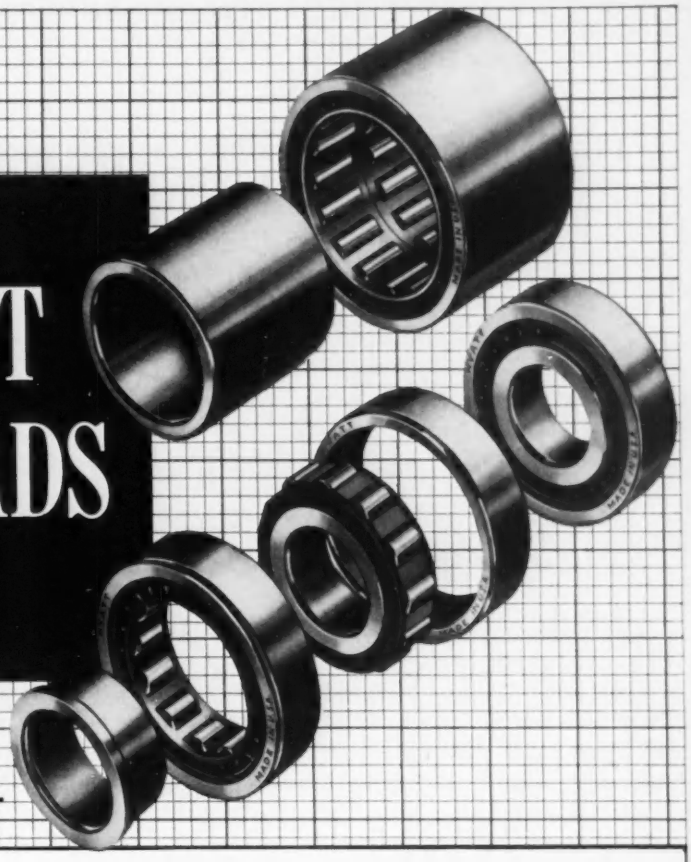
MANUFACTURERS SINCE 1849 COATINGS • COMPOUNDS • CHEMICAL PRODUCTS

NEW YORK
2600 Richmond Terrace
Staten Island 3, N. Y.

LINDEN, N. J.

CHICAGO
2600 Federal Street
Chicago 16, Ill.

HYATT HY-LOADS



*Your best bearing bets_*

THE Hyatt Hy-Load line of cylindrical roller bearings, for radial loads or light or intermittent thrust loads, are made in two diameter series, wide and narrow widths, and to standard boundary dimensions.

There are ten different types of Hyatt Hy-Load Roller Bearings. Four have separable inner races, two have separable outer races, and four are non-separable. There is also the duplex, or double-row type of Hyatt Hy-Load with a separable inner race.

* * *

Wide flexibility in design and assembly procedures is possible with Hyatt Hy-Load Bearings. They are designed and built to do most any bearing job and they are your best bet to do that job right. Specify Hyatt Hy-Loads for your new machine design. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.

HYATT ROLLER BEARINGS

Looking for a source for Dependable Copper Tube

— — — PLAIN or FABRICATED?

If copper tube is a component of the product you have been asked to make for the defense effort, look to Wolverine to supply it—either plain or fabricated. As a prime contractor, you may welcome this suggestion, especially if in your regular production you use other materials and different operations.

Here are some of the many reasons why you should choose Wolverine as the source for top quality tube:

1. You have at your command the specialized skill and experience of over 34 years of exclusive tube manufacture.
2. At Wolverine you'll find the most modern and efficient facilities to produce the tubular part that will meet your specifications.
3. Your problem will be accepted with a thorough understanding and regarded in utmost confidence. We are accustomed to working with government agencies.
4. Available to you are many specialized processes, like end spinning and finning—both of which were developed by Wolverine.
5. Careful consideration will be given special packaging, palletizing, crating, etc., to assure the receipt of your required tubing or tubular parts in satisfactory condition.

Call on the nearest Wolverine sales office (there's one in every principal city) for any assistance you need. Or consult our Customer Engineering Service located in Detroit.

WOLVERINE TUBE DIVISION

Calumet & Hecla Consolidated Copper Company

INCORPORATED

Manufacturers of seamless, nonferrous tubing

1415 CENTRAL AVENUE • DETROIT 9, MICHIGAN

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA

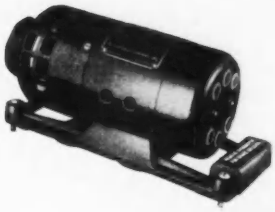
Sales Offices in Principal Cities

Export Department, 13 E. 40th St., New York 16, N. Y.

For Military Requirements...

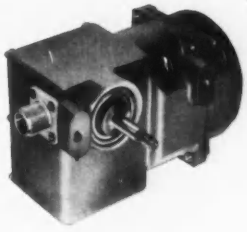
Redmond MicroMotors

DYNAMOTORS . . . WINDSHIELD WIPERS . . . INVERTERS AND OTHER SPECIAL EQUIPMENT



Dynamotors

Special D.C. Micromotors



Windshield Wipers

Inverters . . .
A.C. Generators

If you have a development or production problem to solve on a military product, contact Redmond's and save valuable time. Here's a staff of engineers and production experts with a wealth of experience on electrical rotating equipment.

At Redmond's there are 3000 thoroughly trained specialists in the fine art of manufacturing precision equipment on a mass production basis . . . an able and ready organization.

You'll save time the "Redmond Way." Write for details.

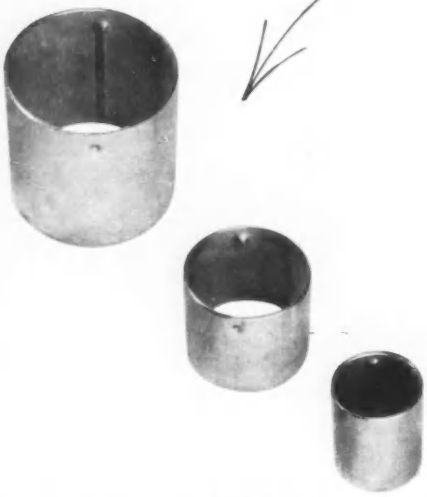
Redmond

REDMOND®

"The BIG name in Small Motors"

REDMOND COMPANY, INC., Owosso, Mich., U. S. A. INDUCTION MOTOR SALES OFFICES: *Eastern Area: 420 Lexington Ave., New York 17, N. Y.; Central Area: Owosso, Michigan; Midwest Area: 332 S. Michigan, Chicago 4, Ill.; Southwest Area: 1330 N. Industrial Blvd., Dallas, Texas; Western Area: (Redmond Company of Calif., Inc.) 1260 S. Boyle Ave., Los Angeles 23, Calif.* **SERIES MOTOR SALES OFFICES:** *Owosso, Mich.* **OVERSEAS SALES OFFICES:** *420 Lexington Ave., New York 17, N.Y., cable address, REDISINC-NEW YORK*

Dentists Can Tell You Why Stainless Tubing for <u>These</u>



Dental molding flasks and saliva ejector stand up under constant use, because they are made from Carpenter Stainless Tubing. The flasks withstand temperatures up to 1700° F., while the ejector is frequently sterilized.

Fabricators can tell you why it's easy to work with *Carpenter* Stainless Tubing!

Reports from dozens of experienced fabricators tell us that there are two reasons why it's easy to work with this tubing. First, analysis-tolerance-finish (and specials such as hardness) are always just the way you want them. That eliminates a lot of problems at the start of any job. Second, they tell us that the personal help they can get on any Stainless Tubing job helps to keep unit costs as low as possible.

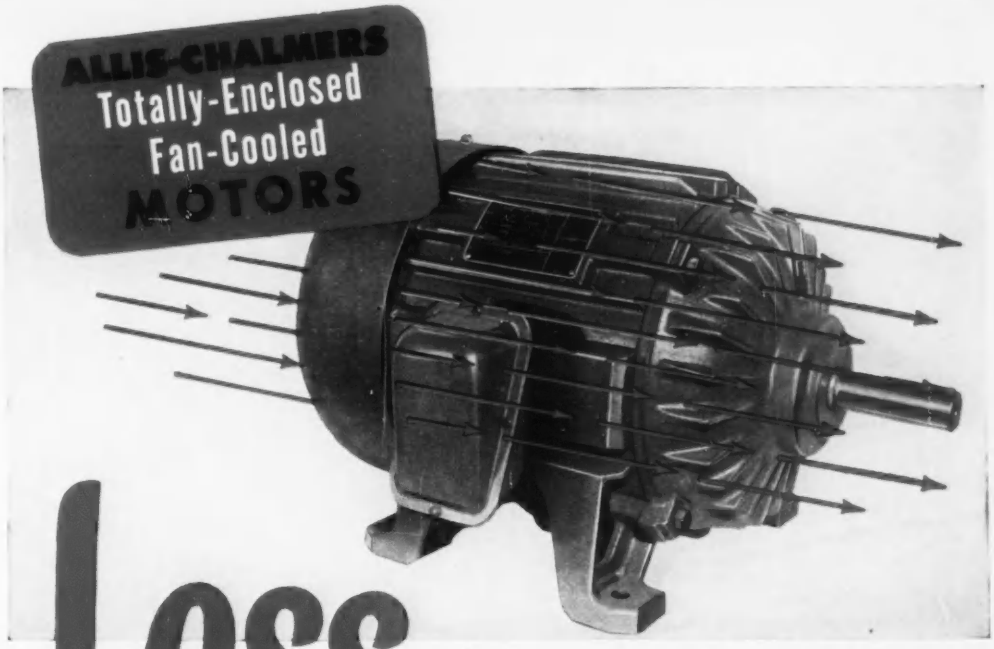
When you want to discuss your design or fabricating problems, call your nearest Carpenter Stainless Tubing Distributor. He will be glad to put his experience to work on your essential jobs, and to help you plan for the future, too.

THE CARPENTER STEEL COMPANY
Alloy Tube Division, Union, N. J.
Export Dept., Reading, Pa., "CARSTEELCO"

Carpenter

STAINLESS TUBING

—guaranteed on every shipment



Less MOTOR CLEANING ...INSPECTION...OVERHAUL!

HERE'S A MOTOR that actually blows itself clean! Dirt is carried away by cooling air blown over the ribbed cast iron frame and bearing housings of this new Allis-Chalmers tefc motor.

Dirt can't build up to cause overheating. Concealed air passages and pockets have been eliminated. Even oily dirt that sticks can simply be wiped or blown off.

And this means savings! Maintenance costs are traditionally low on totally-enclosed, fan-cooled motors. But they're lower than ever before on the new Allis-Chalmers Type APZ tefc motor.

Rigid Construction

The frame is cast iron which has high resistance against corrosion and distortion. Bearings are pre-lubricated at the factory and should need no attention for years. Tapped holes with pipe plugs to permit regreasing and to provide grease relief are standard equipment.

Get All The Facts

The new Allis-Chalmers Type APZ totally-enclosed, fan-cooled motor is built in all NEMA standard frame sizes from 224* to 505. Also in explosion-proof type. Your A-C Authorized Distributor or District Office has complete information. Call today, or write Allis-Chalmers, Milwaukee 1, Wisconsin. Ask for Bulletin 51B7225. A-3426

*Similar design non-ventilated motors Type APK, also available in frames 203 to 224 inclusive.

Sold . . .
Applied . . .
Serviced . . .

by Allis-Chalmers Authorized Dealers, Certified Service Shops and Sales Offices throughout the country.

CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.

TEXROPE — Belts in all sizes and sections, standard and *Vari-Pitch* sheaves, speed changers.

PUMPS — Integral motor and coupled types from ¾ in. to 72 in. discharge and up.

Texrope and Vari-Pitch are Allis-Chalmers trademarks.

ALLIS-CHALMERS

HEAVY DUTY GIANT *REQUIRES* HIGH DUTY MATERIAL

MEEHANITE CASTINGS *SPECIFIED*

Illustrated is a giant billet shear and the main Meehanite housing casting used in its construction. This shear will cut a hot steel billet from 16″ x 16″ square bars and the severity of its operational requirements demand the superior properties of Meehanite castings for its main housing.

Of particular importance in this instance were the high tensile strength characteristics—50,000 psi minimum and the ability to absorb the vibratory stresses set up during operation.

The casting weighed 52 tons and the shear was designed and supplied by Loewy Rolling Mill Division, Hydro-Press, Inc., New York and built in the shops of Farrel-Birmingham Co., Inc., Ansonia, Connecticut.

The superior engineering properties of Meehanite castings are achieved without alloys;—important in times of shortages, stockpiling and today's materials problems.

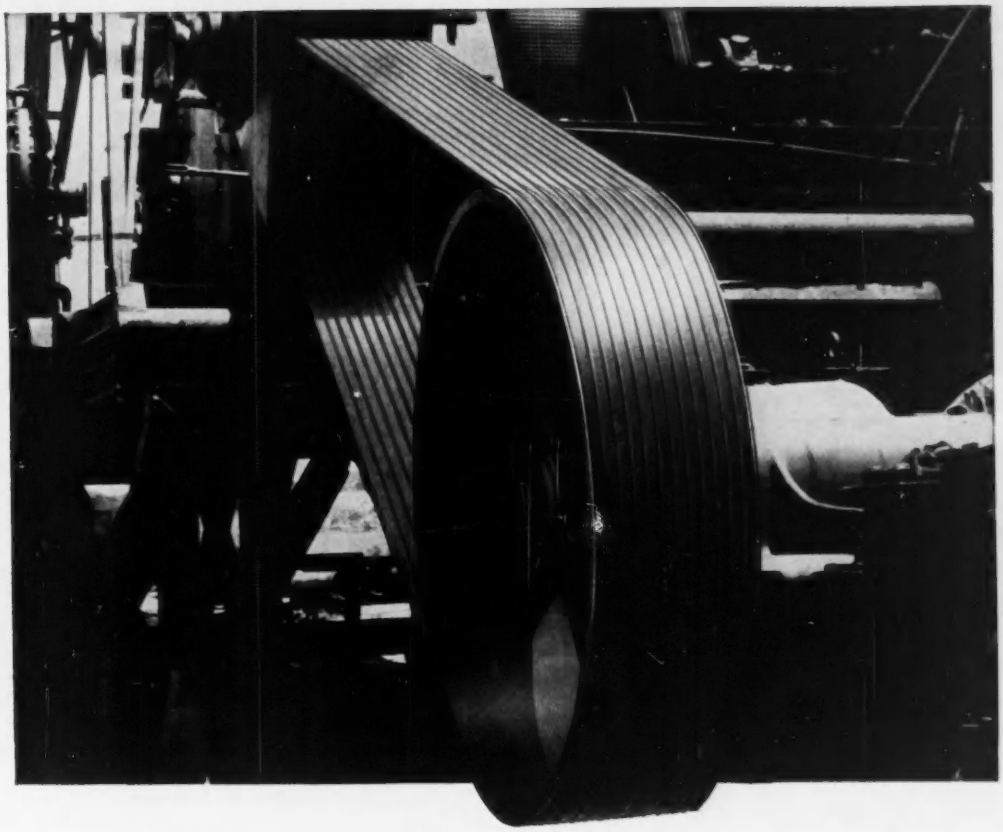
MEEHANITE®

WHEN YOU NEED "EXTRAS" IN QUALITY OR PROPERTIES
CONSULT ANY OF THE FOUNDRIES LISTED BELOW

American Brake Shoe Co	Mahwah, New Jersey
The American Laundry Machinery Co	Rochester, New York
Atlas Foundry Co	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co	Irvington, New Jersey
E. W. Bliss Co	Hastings, Mich. and Toledo, O.
Builders Iron Foundry	Providence, Rhode Island
Continental Gin Co	Birmingham, Alabama
The Cooper-Bessemer Corp	Mt. Vernon, Ohio and Grove City, Pa.
Crawford & Doherty Foundry Co	Portland, Oregon
Empire Pattern & Foundry	Tulsa, Oklahoma
Farrel-Birmingham Co., Inc	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co	Florence, New Jersey
Fulton Foundry & Machine Co., Inc	Cleveland, Ohio
General Foundry & Manufacturing Co	Flint, Michigan
Greenlee Foundry Co	Chicago, Illinois
The Hamilton Foundry & Machine Co	Hamilton, Ohio
Hardinage Co. Inc	New York, New York
Hardinage Mfg. Co	York, Pennsylvania
Johnstone Foundries, Inc	Grove City, Pennsylvania
Kanawha Manufacturing Co	Charleston, West Virginia
Lincoln Foundry Corp	Los Angeles, California
E. Long Ltd	Orillia, Ontario
Otis Elevator Co., Ltd	Hamilton, Ontario
The Henry Perkins Co	Bridgewater, Massachusetts
Pohlman Foundry Co., Inc	Buffalo, New York
Rosedale Foundry & Machine Co	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co	Dover, Ohio
Standard Foundry Co	Worcester, Massachusetts
The Stearns-Roger Manufacturing Co	Denver, Colorado
Traylor Engineering & Mfg. Co	Allentown, Pennsylvania
Valley Iron Works, Inc	St. Paul, Minnesota
Vulcan Foundry Co	Oakland, California
Warren Foundry & Pipe Corporation	Phillipsburg, New Jersey

"This advertisement sponsored by foundries listed above."

NEW ROCHELLE, N. Y.



Next Time You Buy V-Belts Remember:

Bull Dog Compounds do not Crack or Deteriorate Under Severe Flexing!

Bull Dog compounds run cooler and do not crack or deteriorate under severe flexing. This simple fact explains in great part the steady, smooth, *low cost* performance of Bull Dog V-Belts . . . and their longer life! *Remember it — it will pay you well.*

Remember, also, that Bull Dogs are processed for *minimum stretch.* You'll see the operating benefits in reduced slippage and the elimination of repeated adjustments.

Durable Covers are another "more for your money" advantage — and worth remembering. Bull Dog covers are closely woven of heavy, bias cut fabric. They can withstand the punishing wear of the sheave while sealing the belt against moisture, dirt and grease.

Remember, too, that the *specially engineered* BWH cord section is outstanding in high tensile strength. This means you'll get the superior load carrying capacity you want — and the ability to absorb shock loads. What's more, when you install Bull Dogs in sets (and it's highly recommended) you are matching the uniform superiority of one Bull Dog belt with another.

TOUGH PROBLEMS INVITED— Ask us or your nearest BWH distributor about your V-belts, transmission belting, conveyor belting and hose problems. He is a specialist in making rubber products work *better, longer.*

BWH
DEPENDABLE RUGGEDNESS

Another Quality Product of

BOSTON WOVEN HOSE & RUBBER COMPANY

Warehouse Stock: 111 N. Canal St., Chicago, Illinois — Distributors in all Principal Cities

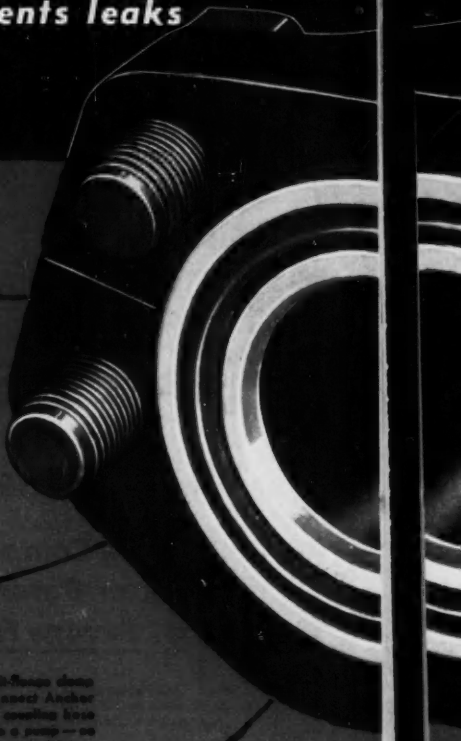
PLANT: CAMBRIDGE, MASS. • P. O. BOX 1071, BOSTON 3, MASS., U. S. A.

Announcing **Anchor Coupling Co.'s latest development for the hydraulic field**

-the New Split-Flange Clamp

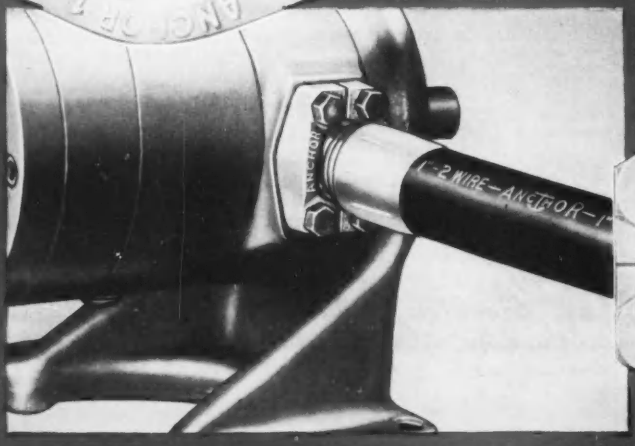
(Patents Pending)

. . . a revolutionary type of clamp that's easy to use, eliminates threaded joints, and prevents leaks



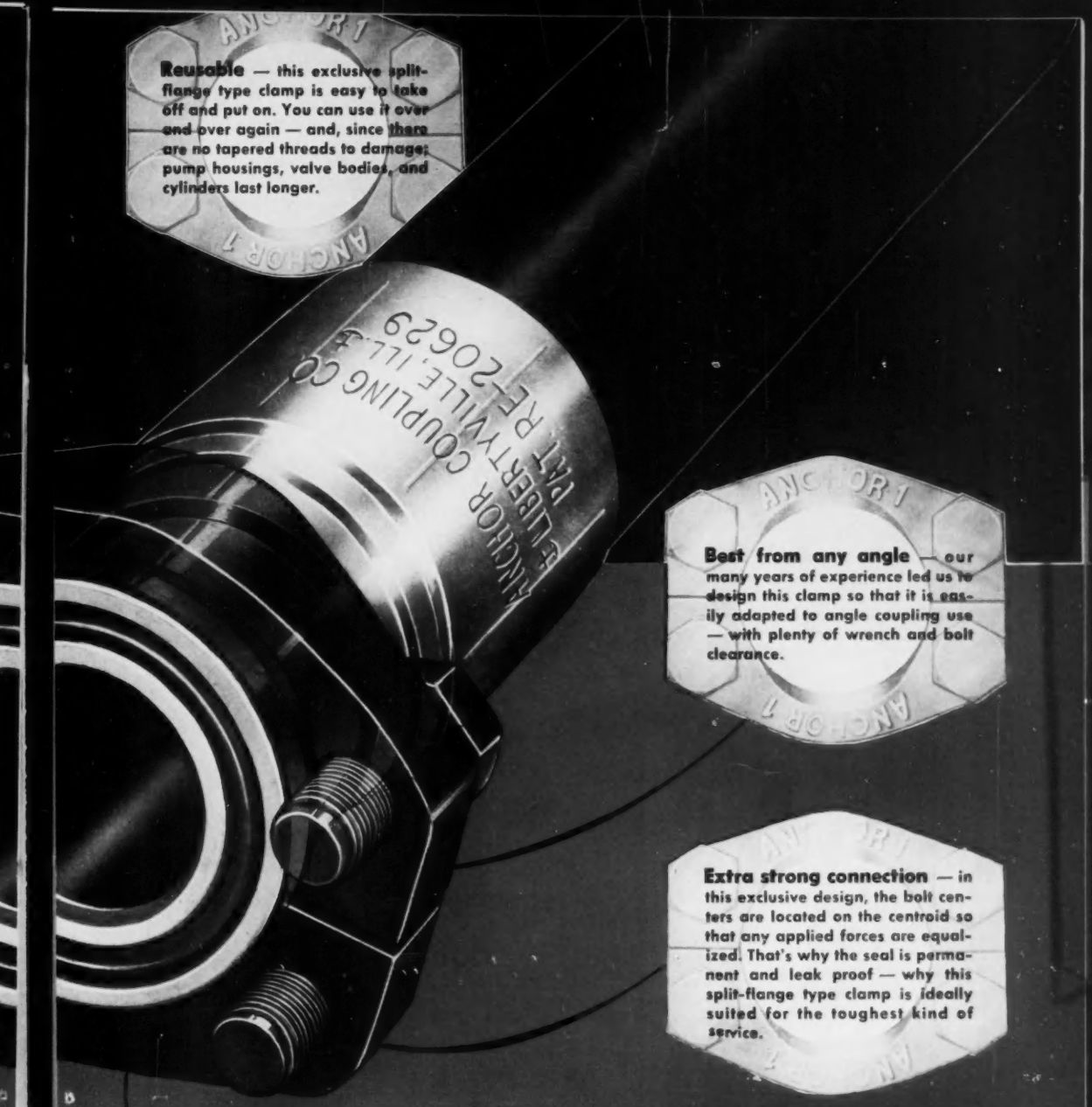
Wide selection — available in clamp- or pressed-on type couplings, in straight or angle styles for 1- or 2-wire braid hose, sizes from ½-inch ID through 2-inch ID. Ideal for high, medium, or low pressure service and suction return lines.

Easy to assemble — No big pipe wrench needed — just use a small, convenient, automotive-type wrench. This gives you greater clearance — there is no straining, less effort. Also eliminates use of pipe-thread compounds.



Left — split-flange clamp used to connect Anchor pressed-on coupling hose assembly to a pump — no tapered threaded joints, no leakage.

Leak proof — the "O" ring, proven so successful in countless hydraulic applications, provides a perfect static seal. There are no tapered threads. There's no wedging action to cause distortion in valve bodies, cylinders, etc.



Reusable — this exclusive split-flange type clamp is easy to take off and put on. You can use it over and over again — and, since there are no tapered threads to damage; pump housings, valve bodies, and cylinders last longer.

Best from any angle — our many years of experience led us to design this clamp so that it is easily adapted to angle coupling use — with plenty of wrench and bolt clearance.

Extra strong connection — in this exclusive design, the bolt centers are located on the centroid so that any applied forces are equalized. That's why the seal is permanent and leak proof — why this split-flange type clamp is ideally suited for the toughest kind of service.

Versatile — eliminates need for separate union connection. Provides union connection at one or both ends of the hose. Permits the use of short, stiff lengths of hose because no deflection of hose assembly is required in making up the joint — there's no need to disturb your plumbing.

Tear out this coupon and mail today

Anchor Coupling Co, Inc., Dept. PS-111, Libertyville, Illinois

I am interested in the features of this new easy-to-use split-flange clamp that eliminates threaded joints and prevent leaks. Please send me your new Bulletin giving further details.

Name ..... Position .....

Company .....

Company Address .....

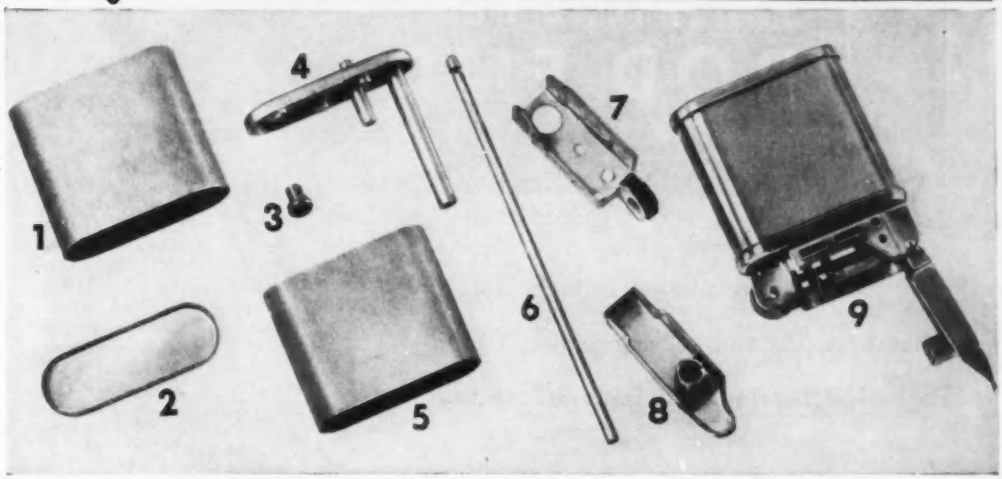
City ..... ( ) State .....

you Specify
if it's a wire spring .
spring washer . . . . . .
flat spring . . . . . .
or wire form . . . . .
we make it!
Wallace Barnes Springs
Bristol Connecticut

BRIDGEPORT BRASS COMPANY

COPPER ALLOY BULLETIN

"Bridgeport" MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL



Parts and assemblies for pipe and cigarette lighter: 1. Outside body; 2. Base; 3. Bushing; 4. Top cover with wick and flint tubes and screw studs; 5. Inside body; 6. Jet tube with nozzle assembled; 7. Windshield with flint wheel assembled; 8. Snuffer assembly with snuffer and flat spring. Beattie Jet Lighter is shown at right—Courtesy Waterbury Lock & Specialty Co., Milford, Conn.

Accuracy Necessary to Produce Brass Parts for Jet Lighter

Accurate press, eyelet and screw machine parts, plus precision tubing are essential for both functional and assembly purposes in the illustrated pipe and cigarette lighter.

When the wick is ignited by the flint and the lighter tipped, the flame strikes the jet tube which has a wick inserted in it and runs down through the packing holding the lighter fluid. The heat causes the fluid drawn into the jet tube by the wick to change from a liquid to a gas, producing sufficient pressure to jet out a flame long enough to reach down into bowl of a pipe.

High Brass Used

The tubing, press and eyelet parts are made from high brass (65% copper, 35% zinc) for ease of drawing and forming, strength, corrosion resistance and suitability for buffing and plating.

The screw machine parts are made from free turning brass rod (61% copper, 3.4% lead and balance zinc). This alloy has the highest machinability rating of the copper-base alloys and also has the ability to accept and hold a plate.

Body Tubes Slip Fit

Two pieces of tubing (1 and 5) are held to tolerances which permit a slip fit to form the body of the lighter. To the outside piece of tubing is soldered the base (2), which is blanked, drawn, trimmed, then stamped with the name of the lighter and company.

The top cover (4) is blanked, cupped and trimmed. Four holes are pierced and the fifth is extruded to hold the bushing which takes the torch tube.

The two shortest screw machine pieces have blind tapped holes and a turned shoulder. These take screws to hold on the windshield. The longest rod is drilled through and tapped at one end for the flint adjusting screw. The second longest is drilled completely through to take the wick. All four parts are either swedged or staked into the cover. The bushing (3) is a press fit, and is produced in a screw machine.

Torch Nozzle Drawn

The jet tube (6) is reduced on one end over which is pressed the torch nozzle. At first it appears as though this part would be made in an eyelet machine but it was found that by blanking, cupping and drawing a more accurate fit would be maintained.

The nozzle hole is .004 in. in diameter. This hole is pierced with a special punch in a small press.

Accurate Forming Necessary

The windshield (7) is blanked, pierced and then two forming operations are performed. The forming is accurate enough to bring into alignment the two right-angle holes. The flint wheel is assembled into the shield with a small eyelet which is swedged over on one end after assembly.

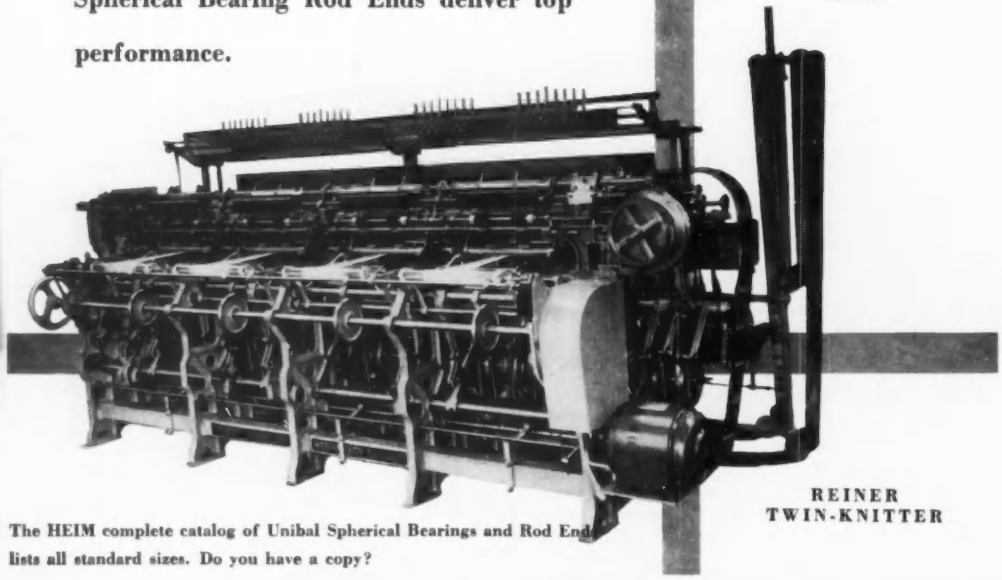
The snuffer cover (8) is blanked, formed. Two piercing operations complete it. The snuffer itself is a screw machine part on which is turned a small diameter which serves as a rivet to attach the snuffer and the spring-tempered flat spring to the cover.

All assemblies on parts are nickel-chrome plated. (7227)

HEIM *Unibal*
SPHERICAL BEARING ROD ENDS

Heim HF-10 Rod Ends are part of the Pointex Roller Shift assembly, and Heim HF-6 are used in the Rocker Latch Safety assembly on the Reiner Twin-Knitter.

Wherever motion is to be transmitted at odd and varying angles, HEIM Spherical Bearing Rod Ends deliver top performance.



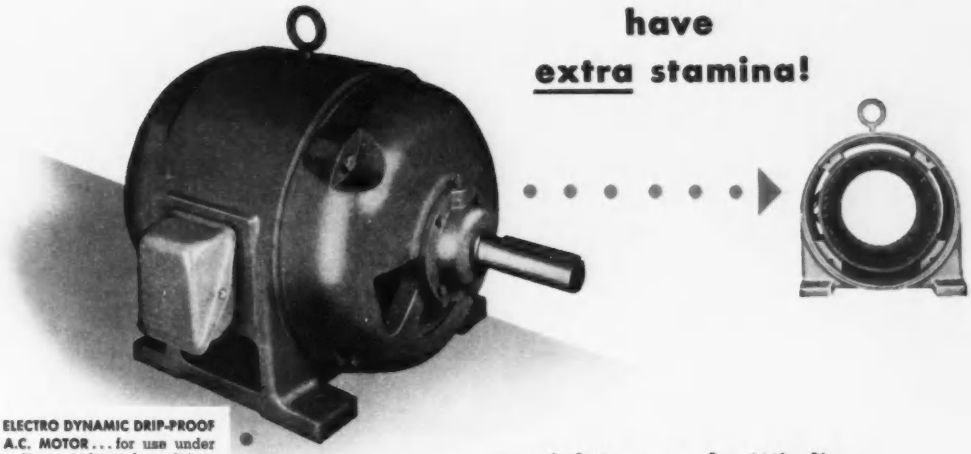
REINER TWIN-KNITTER

The HEIM complete catalog of Unibal Spherical Bearings and Rod Ends lists all standard sizes. Do you have a copy?

THE HEIM COMPANY
FAIRFIELD, CONNECTICUT

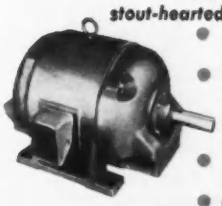
ELECTRO DYNAMIC MOTORS

have
extra stamina!



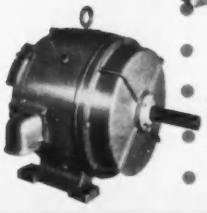
ELECTRO DYNAMIC DRIP-PROOF A.C. MOTOR . . . for use under ordinary industrial conditions not requiring protection from splashing liquids or from atmosphere laden with dirt or metal chips.

E. D. MOTORS are *stout-hearted* motors!



SPLASH-PROOF A.C. . . . For installation where the motor is subjected to splashing liquids or to hosing down for cleaning.

TOTALLY ENCLOSED (Fan Cooled) A.C. . . . . For dirt-laden atmosphere, especially in installations requiring a motor of compact dimensions.



DRIP-PROOF D.C. . . . . Adjustable speed motor for general industrial use.

Special Care at the Windings— "THE HEART OF THE MOTOR"— Creates Unique Durability

When you install Electro Dynamic motors you can say goodbye to worries over critical motor failures and costly maintenance expense.

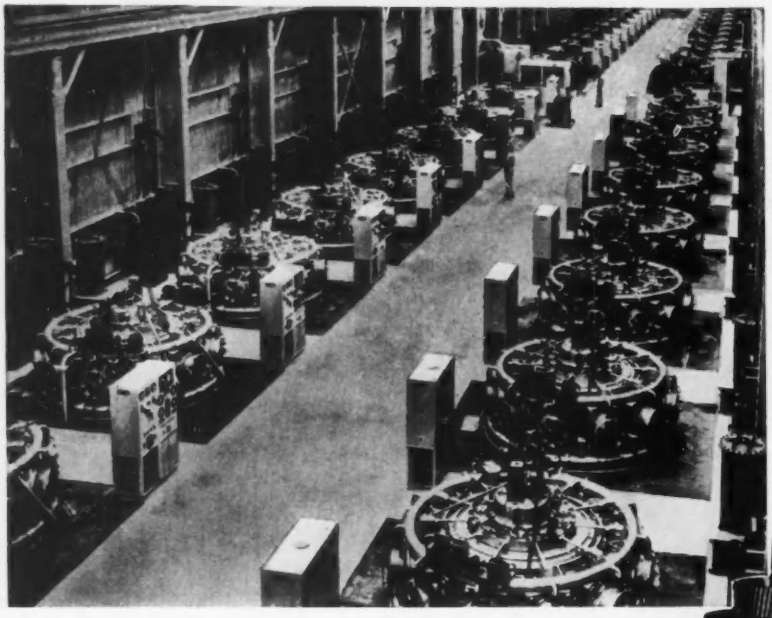
For E.D. motors, although competitively priced, are built with special care at the windings—"the heart of the motor". Here men of unusual experience and skill work with superior materials to produce windings that are tough and durable far beyond the demands of ordinary industrial use. The exacting needs of the *marine* field long ago taught E.D. how to produce motors with great stamina and dependability!

Every E.D. motor is dynamically balanced. All frames are corrosion-resistant and are of heavy cast construction. Write today for illustrated literature on this fine line of motors.

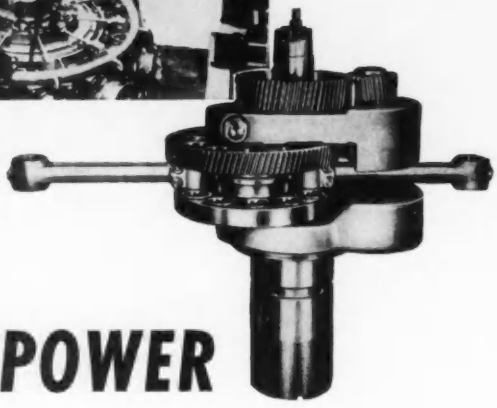
Industry has learned what marine engineers have known since 1880

ELECTRO DYNAMIC builds great motors

ELECTRO DYNAMIC • Division of the Electric Boat Company • Bayonne, New Jersey



In world's largest internal combustion engine plant, operated by ALCOA, low cost power is essential for producing aluminum since every pound produced requires about 10 kilowatt hours of electrical power. *Right:* Nickel alloy cast iron crankshaft, weighing over 5,000 lbs., with gear train assembly, used in gas burning radial engine manufactured by Nordberg Mfg. Co., Milwaukee, Wisc.



200,000 HORSEPOWER

24 hours per day on NICKEL CAST IRON CRANKSHAFTS

Here are some of the 120 Nordberg radial engines with vertical crankshafts of nickel cast iron which provide low cost power at the Point Comfort Reduction Works of the Aluminum Company of America, Port Lavaca, Texas.

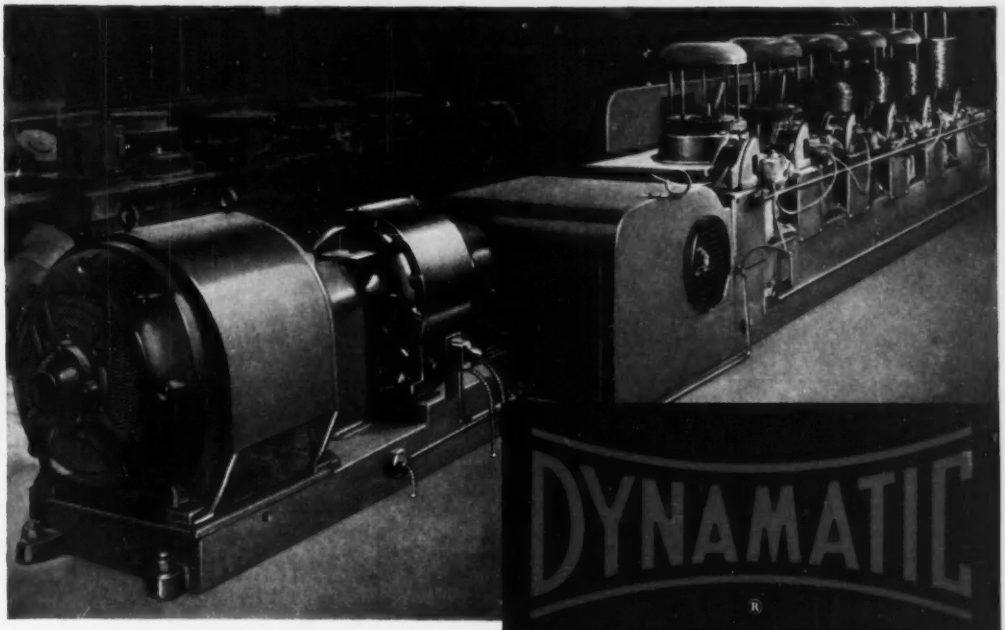
High strength nickel alloy iron is used not only for these crankshafts, but also for the cylinder blocks. In addition, many highly stressed parts of these 11-cylinder engines are made from heat treated nickel alloy steels.

Powered by natural gas from nearby fields, these Nordberg units demonstrate how nickel alloyed irons and steels help to cut bulk and deadweight, and to render further economies by minimizing wear and corrosion.

At the present time the National Production Authority limits the applications for which nickel and its alloys may be used. However, we shall continue to issue information on user experience with nickel-containing materials as we believe that dissemination of technical data and service experience can help to promote the intelligent utilization of critical materials, so essential in these times.

SYMBOL OF INCO SERVICE

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N.Y.



Model 7W Dynamatic Water-Cooled Coupling driving a wire machine which draws 7/32" wire to .070" in six dies. Power is derived from a 200 HP, 1200 RPM induction motor.

DYNAMATIC®

WATER-COOLED POWER COUPLINGS

Adjustable Speed Drives for Industrial Use

Dynamic Water-Cooled Couplings provide adjustable speed drive direct from an AC power source for a wide range of industrial applications. They transmit rotation from a driving to a driven member without mechanical contact with stepless adjustable control and almost instantaneous response. A simple method of providing adjustable speed from a constant speed source (or vice-versa) with full torque starts.

Effective water-in-the-gap cooling permits large capacity in small space; design provides complete protection against atmospheric impurities.

Standard sizes are available for transmitting torques of 50 pounds feet to approximately 5,000 pounds feet. Units up to 200,000 pounds feet or larger can be built to order.

Write for Illustrated Booklet WC-1

WIDE SPEED RANGE
INSTANTANEOUS RESPONSE
ACCURATE SPEED CONTROL
STEPLESS SPEED ADJUSTMENT
SMOOTH TORQUE TRANSMISSION
TOTALLY ENCLOSED
SIMPLE • QUIET
COMPACT • EFFICIENT

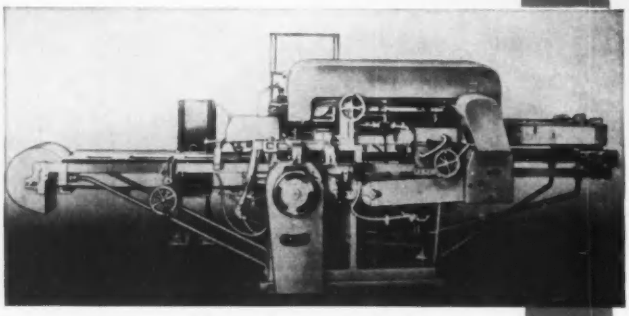
DYNAMATIC® CORPORATION • KENOSHA WISCONSIN

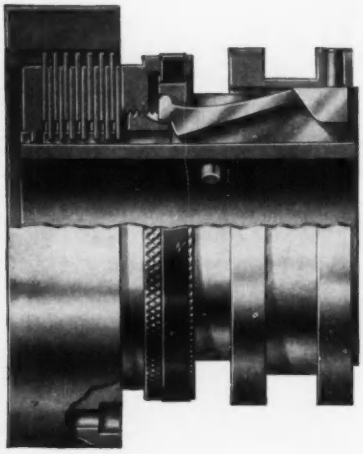
Subsidiary of **EATON MANUFACTURING COMPANY,** Cleveland, Ohio

Dynamometers • Oil Well Draw-Works Brakes • Adjustable-Speed Couplings • Eddy-Current Brakes
Ajusto-Spedes • Shovel Clutches • Press Drives • Lift Truck Clutches • Electronic Controls

MAXITORQ

Keeps Good Company





. . . in the PACKAGING FIELD

The MAXITORQ floating disc CLUTCH takes care of power transmission in this Model FF packaging machine, used in freezer plants to overwrap frozen food packages.

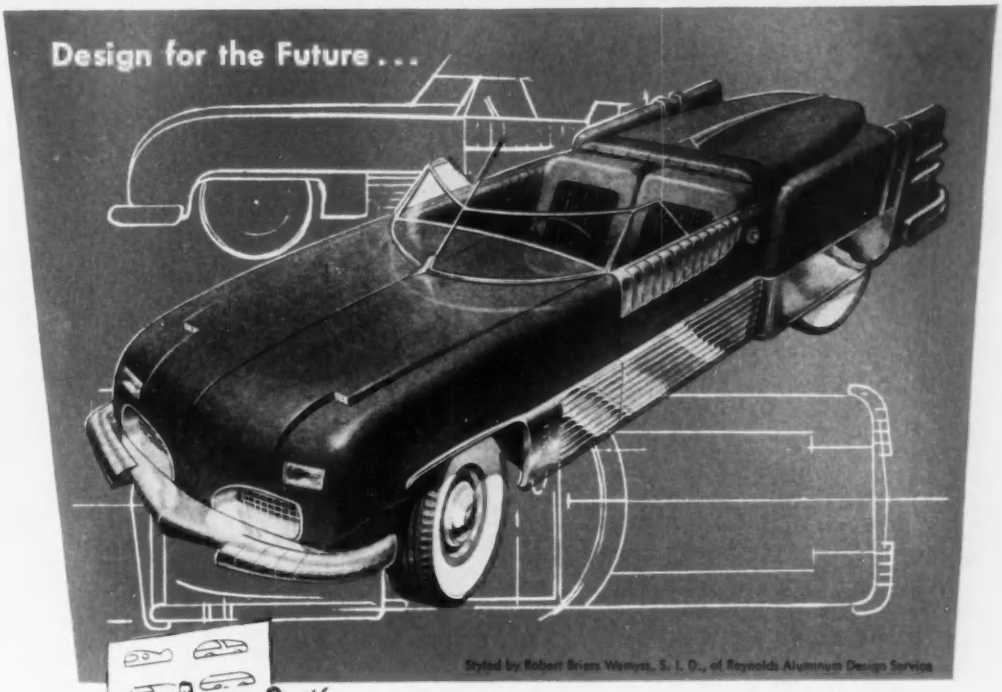
The Package Machinery Company, Springfield, Mass., one of the largest manufacturers of packaging machinery in the world, builds approximately 100 different models of machines. Their engineers say, "We have been so well satisfied with the Maxitorq Clutch that we have adopted it as standard on practically all machines we build that require a clutch type of drive."

This specific Maxitorq is the NO. 23, single dry type, 1 H.P. at 100 r.p.m., 4-1/32" long, 3-15/16" dia. There are 8 standard capacities, 1/4 to 15 H.P. single or double, wet or dry. Separator springs keep discs "floating" in neutral . . . prevent drag, abrasion, heating. Assembly, adjustment, take-apart are manual . . . no tools required. Disengagement is instant and complete.

Within its capacity, the Maxitorq Clutch serves many applications for machine tools, industrial products, mowers, textile, printing, mining, lumbering, packaging and a host of other machines. Ask for our engineering recommendations . . . join "Maxitorq's good companies."

Send for Catalog No. PE 11

THE CARLYLE JOHNSON MACHINE COMPANY
MANCHESTER • CONNECTICUT



To the Executive Planning for TOMORROW...

Here's a forecast of your new automobile for the 1960's. Leading automotive manufacturers have just such advance models *now* . . . designs that are virtually all aluminum and other light alloys. Even the more powerful engines will be constructed of lightweight metals. And just as *today's* models include the features from forecast designs of a decade ago, ideas from present advance models will be used in *tomorrow's* production.

Profit from the "future-thinking" automotive engineer . . . put aluminum on your drawing boards for *tomorrow's* designs. Supplies of bauxite ore are ample for generations and this, together with expanding aluminum production facilities assures a steadily mounting supply of *tomorrow's main metal* . . . at a consistently low price.

Reynolds Aluminum Specialists are now working with many companies on their future designs. They will be glad to work with your designers to assure you of the maximum benefits of aluminum—low cost, lightweight with strength, natural attractiveness, wide range of finishes, freedom from destructive rust, ease of fabrication.

Today, call the Reynolds office listed under "Aluminum" in your classified telephone directory. Or, write to Reynolds Metals Company, 2510 South Third Street, Louisville 1, Kentucky.

and to the Man in Charge of TODAY'S PRODUCTION!

Do you have a defense contract that specifies aluminum? To eliminate production problems, acquaint yourself with the accepted production techniques for fabricating aluminum. Write for complete list of Reynolds technical books covering every phase of fabrication. And for *special* problems, take advantage of Reynolds trained staff of aluminum specialists.

Be sure to see the Kate Smith Family Hour, NBC-TV, 8 P.M., E.S.T. Wednesdays
***Hear* The Big Show with Tallulah Bankhead, NBC Radio Network, 5 P.M., E.S.T. Sundays**

REYNOLDS METALS

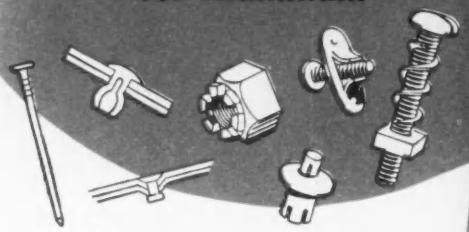
REYNOLDS ALUMINUM

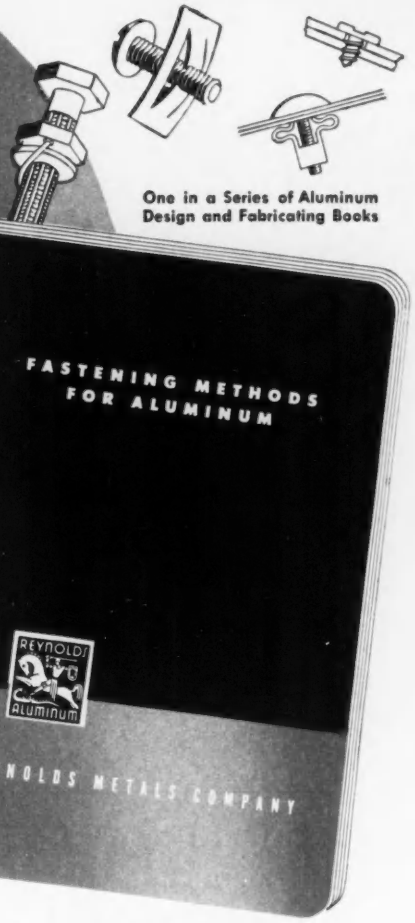
MODERN DESIGN HAS ALUMINUM IN MIND

FREE!

SEND FOR THIS VALUABLE HANDBOOK

"Fastening Methods for Aluminum"





One in a Series of Aluminum Design and Fabricating Books

All you need to know about fastening aluminum components

This 136-page illustrated booklet is a *must* for your desk reference library. All the very latest information on the wide variety of mechanical fastening methods used to join assemblies involving aluminum parts.

There are tables of related data for the various types of standard rivets, including dimensions and number of pieces per pound, lengths of rivets for cone-point and button-type driven heads, recommended hole sizes with shear and bearing areas for both hot and cold-driven rivets, and maximum loads for single rivet in shear.

Answers your questions on standard and special rivets, standard and special screw fasteners, nails and pins, metal stitching, mechanically formed joints, resin bonding and others.

Application of these latest 1951 fastening methods speeds production, means increased capacity and lower costs for you.

And if you have a *special development* problem, take advantage of the trained staff of Reynolds aluminum specialists waiting to help you. Let them show you how to overcome difficulties and set-up for fast, economical production. For prompt service, call the Reynolds office or your distributor listed under "Aluminum" in your classified telephone directory.

SEND FOR THIS VALUABLE HANDBOOK TODAY!

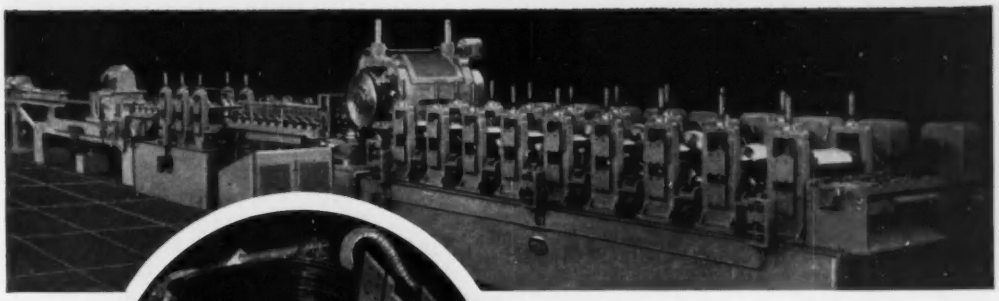
Get your free copy of "Fastening Methods for Aluminum" and a complete index of Reynolds technical literature. Please request on business letterhead (otherwise price is $1.00). Write today to Reynolds Metals Company, 2510 South Third Street, Louisville 1, Kentucky.

Be sure to see the Kate Smith Family Hour, NBC-TV, 8 P.M., E.S.T. Wednesdays
Hear The Big Show with Tallulah Bankhead, NBC Radio Network, 5 P.M., E.S.T. Sundays

REYNOLDS METALS

REYNOLDS ALUMINUM

MODERN DESIGN HAS ALUMINUM IN MIND



IMPORTANT ADVANCE IN *Tube Welding*

Up to 20% Higher Production

Yoder now announces the greatest forward step in tube welding since the introduction of the first patented Yoder Tube Welder in 1939. The enviable production records established by this welder largely account for the fact that Yoder has furnished more than half of all the resistance-weld tube mills since installed in the U.S.A.

The heart of the new welder is a transformer of revolutionary design. It consists of four smaller transformers surrounding a common core and making an assembly of unprecedented compactness and strength. Reduced impedance accounts for its higher electrical efficiency. It insures longer service life, fewer interruptions for servicing, repairs and maintenance.

Compared with the previous Yoder welder, the production gains may be as high as 20%; compared with other tube welders, the gain may be as high as 50 to 60%. These gains go far toward compensating for increased labor and material costs.

The welder is furnished with all new Yoder tube mills, and is also available for replacing welders in other makes of resistance-weld mills, to step up production and reduce conversion cost.

Descriptive literature, consultations and estimates for the asking.

THE YODER COMPANY • 5522 Walworth Avenue • Cleveland 2, Ohio

Complete Production Lines

- ★ **COLD-ROLL-FORMING and auxiliary machinery**
- ★ **GANG SLITTING LINES for Coils and Sheets**
- ★ **PIPE and TUBE MILLS–cold forming and welding**

ENGINEERING YODER MANUFACTURING

PROBLEM:

How to Simplify and Speed Up Contact Brazing of Multiple Leads from a Screen

GENERAL PLATE

Provided the Solution with a "Solder-Flushed" Metal . . . A Composite Metal Combination

Recently a manufacturer had the problem of soldering leads from a screen to a copper strip. The old method required cleaning and positioning separate pieces of solder on each spot and then heat. This method was time consuming and costly.

General Plate Engineers solved the problem with "Solder-Flushed Copper Strip." Now the operation involves laying the leads on the strip and heating each wire. The result—a strong soldered joint at considerable savings in time.

General Plate "Solder-Flushed" metals make contact brazing quicker and easier. They eliminate handling of separate pieces of solder foil, provide a better, stronger joint. They can be supplied with solder to base or precious metal, copper layer for copper brazing or low silver content solder clad to base metal.

No matter what your metal problem, it will pay you to consult with General Plate. Their vast experience in cladding precious to base metals, or base to base metals can overcome your problems...often reduce costs.

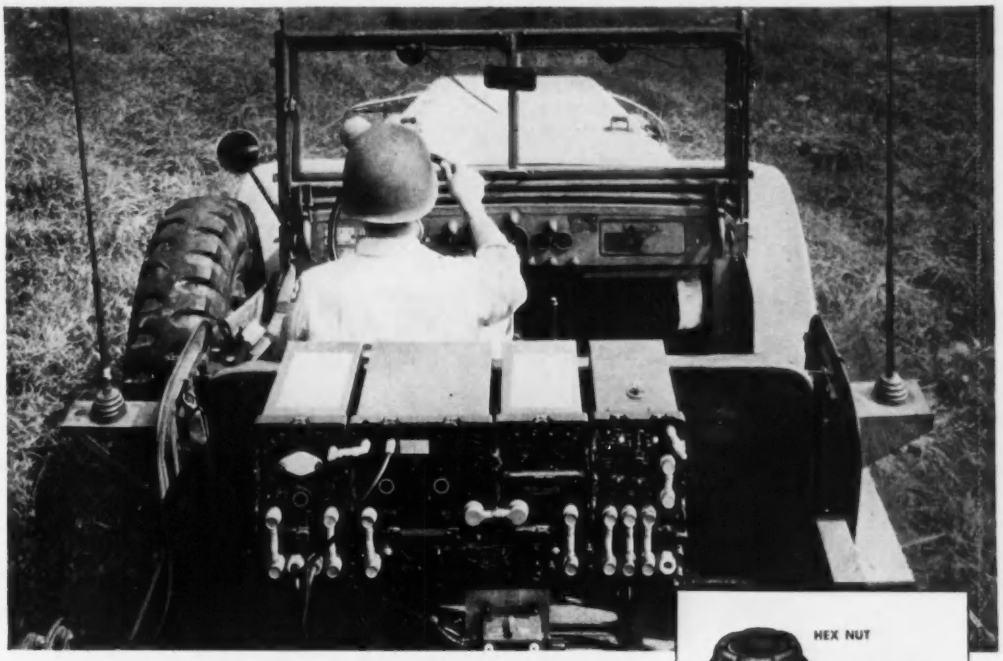
General Plate Products include . . . Precious metals clad to base metals, Base metals clad to base metals, Silver solders, Composite contacts, buttons and rivets, Truflex® Thermostat metals, Platinum fabrication and refining, Age-hardenable, #720 Manganese Alloy. Write for information.

Have You a Composite Metal Problem? General Plate can solve it for you

GENERAL PLATE

Division of Metals & Controls Corporation

111 FOREST STREET, ATTLEBORO, MASS.



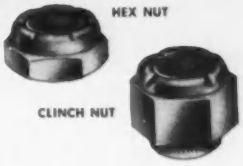
Guarding Signal Corps Equipment from Fastener Failure

Communications equipment for mobile tactical units must be sturdy enough to follow the front lines cross-country and along battle-pitted roads. This AN/GRC-3 radio equipment, installed in all types of combat vehicles, must be ready to provide communications liaison between advancing units. And it must be ready twenty-four hours a day, despite the roughest operating conditions. For vital equipment of this type there is a growing recognition of the need for self-locking fasteners to protect the expensive and critical component parts which make them function.

Helping to keep this equipment operating by holding against severe and long-continued vibration are many ESNA machine screw hex nuts and clinch nuts. These Elastic Stop Nuts—*with fungus proof nylon inserts for extended reuseability*—offer the advantages of secure fastenings and at the same time simplify maintenance and field repairs.

ESNA HEX NUTS are quickly installed with power tools—permit accurate, precise adjustments, lock at any position along the bolt, and keep fastenings tight until deliberately removed.

ESNA CLINCH TYPE NUTS are available in various shank lengths for swaging on different gauges of sheet metal. Permanently clinched into place on frame members or to sections of the chassis, they provide permanent and pre-positioned fasteners for assembling panels or mounting component parts.



Red Nylon **locking inserts**
Reusable over 100 times

DESIGN AHEAD WITH ESNA

THE FAMOUS RED ELASTIC COLLAR IS VISIBLE EVIDENCE OF LOCKING SECURITY

Threadless and permanently elastic, it provides these 4 outstanding features:

1. Protects against nuts loosening due to VIBRATION
2. Keeps locking threads CORROSION FREE
3. Provides for accurate BOLT LOADING
4. Seals against LIQUID LEAKAGE along the bolt threads

And can be used again and again

ESnail® ESNA ROLLPIN™

ELASTIC STOP NUTS

DESIGN HEADQUARTERS FOR VIBRATION-PROOF FASTENERS

Specify ESNA hex and clinch nuts with the new red nylon insert to assure adequate locking torque through hundreds of on-off applications.

When you design equipment that needs similar fastening security, specify Elastic Stop Nuts. For complete dimensional and installation data write to Elastic Stop Nut Corporation of America, Vauxhall Road, Union, N. J.

Mallory Jacks and Plugs

for exacting specifications

Shown above are several military type Mallory jacks and plugs, including a new booted jack for applications requiring waterproof design. The complete line includes these five basic types for civilian and mobilization uses:

1. Long Frame Jacks—Threaded bushing. Mounting takes up depth, but little panel space. The spring stack-ups are mounted horizontally to the frame in a variety of spring combinations.

2. XP Long Frame Jacks—Plain, unthreaded bushing. Mounting is accomplished by a screw-nut combination. Takes up depth, but little panel space. These jacks serve the same purpose as the Mallory Standard Long Frame Jacks, but a special frame angle is employed to give greater support.

3. Junior Jacks—Threaded bushing. Mounting is parallel to panel, thus requiring less depth, but more panel space. Built with the frame supporting the spring stack at a right angle so that the jack extends only $1\frac{5}{16}$" back of the panel.

4. SC Jacks (Signal Corps Type)—Threaded bushing. Condensed size with medium panel area, minimum depth. Designed for use in all applications, but especially where limited space is important.

5. "Grounding" Jacks No. GJ-1—Threaded bushing. Used in military aircraft to "ground" planes while refueling.

The precision and dependability of the Mallory line of jacks and plugs are the result of a unique combination of research facilities and production skill.

Specialized experience in the related fields of metallurgy, electrical contacts and electronics qualified Mallory to work in close cooperation with the Armed Services Electro Standards Agency since its inception. Mallory jacks and plugs meet a wide variety of application requirements and include a number of military types complying with JAN specifications.

Mallory jacks and plugs are available for your most exacting needs. Qualified engineering service and technical data are available on request.

Television Tuners, Special Switches, Controls and Resistors

P. R. MALLORY & CO. Inc.

MALLORY

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

SERVING INDUSTRY WITH

Electromechanical Products
Resistors *Switches*
TV Tuners *Vibrators*

Electrochemical Products
Capacitors *Rectifiers*
Mercury Dry Batteries

Metallurgical Products
Contacts *Special Metals*
Welding Materials

Eaton Permanent Mold Gray Iron Castings

for

DOMESTIC APPLIANCE PARTS

- **Free machinability**
- **Uniform structure throughout the casting**
- **Good tensile strength**
- **Freedom from growth and segregation**
- **Ability to take a high surface finish**

Send for your copy of the illustrated booklet, "A Quick Picture of the Eaton Permanent Mold Process for Producing Gray Iron Castings."

EATON MANUFACTURING COMPANY

CLEVELAND, OHIO

FOUNDRY DIVISION: 9771 FRENCH ROAD • DETROIT 13, MICHIGAN

PRODUCTS: Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater-Defroster Units • Snap Rings Springtites • Spring Washers • Cold Drawn Steel • Stampings • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers

How to Handle Perishables? The Dairy People Agree 100%

THE handling and processing of milk and milk products is one of the nation's major industries —and a mighty delicate, painstaking business, too! But, if dairymen have never-ending problems of protecting flavor and purity, and of keeping maintenance and cleaning costs down, they also have a never-failing helper. It's Allegheny Metal.

For many years now, practically every item of equipment that has gone into a milk-processing plant has been made of stainless steel. From the receiving tanks to the bottle or package, and from one end of the country to the other, milk products today seldom come in contact with anything but stainless. As good businessmen, dairymen have found that nothing else can do the job as well. No other commercial metal is at once as strong, as corrosion resistant, as easy to clean and keep clean, and as lifetime-lasting in service.

The dairy and food industries, of course, class as essential uses for Allegheny Metal. There are many others: in the processing of chemicals, drugs and petroleum products, for example—and in planes, ships and many other vital items of defense equipment. Naturally, some less essential uses have to give way, but there are ways to spread the supply of stainless steel farther.

For one, we're continuing our many-million-dollar program of expanding production. For others, we offer every assistance to fabricators to make more efficient use of stainless steel, and to find alternate grades which will use less of the critical alloying materials. *Let us work with you!*

* * * * *

Complete technical and fabricating data—engineering help, too—are yours for the asking from Allegheny Ludlum, the nation's leading producer of stainless steel in all forms. Branch Offices are located in principal cities, coast to coast, and Warehouse Stocks of Allegheny Stainless Steel are carried by all Joseph T. Ryerson & Son, Inc. plants. ● *Address* Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Penna.

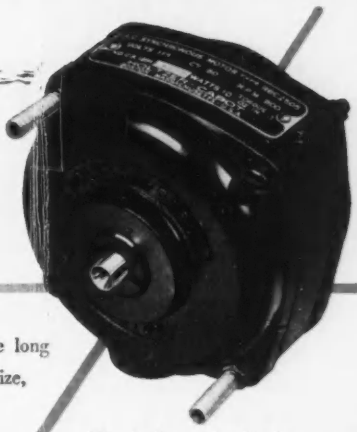
W&D 3774

You can make it **BETTER** with

Allegheny Metal

AL
TIME-TESTED STAINLESS STEEL

Now – greater safety for small boats!



This Holtzer-Cabot motor helps the Fathometer* make 900 soundings per minute!

Owners of small pleasure boats and fishing craft have long wanted a reliable depth sounder that would be small in size, economical in power consumption and low in price.

Now, the Submarine Signal Division of the Raytheon Manufacturing Co., Waltham, Mass., is filling that need with the Fathometer, an echo depth sounder that is amazingly accurate and compact.

The Fathometer CADET shows depths from 1 foot to 160 feet, and indicates the slightest changes in bottom contour. It has proven to be an invaluable aid not only in guiding boats safely through unfamiliar waters but also in discovering and indicating the location and depth of schools of fish.

Here's how the Fathometer works: A transducer installed inside the hull sends out sound waves and picks up the echoes that are "bounced off" the bottom. Depths are indicated by the flash of a whirling light registering against a calibrated dial. The accuracy of these readings is controlled by a Holtzer-Cabot synchronous motor which receives its driving power in the form of "square wave" AC from the vibrator power supply.

Rigid specifications were laid down for the motor to serve in the Fathometer.

The motor specified had to be a slow speed (900 RPM), synchronous type, 115 volts, 60 cycle single phase with 0.1 ounce inches torque. It also had to be totally enclosed and suitable for continuous duty, with input of 11 watts under full load.

Other specifications: – ability to operate in an ambient temperature range of 0° to 50° C. without exceeding a maximum temperature of 105° C.; minimum life, 1000 hours of operation.

Holtzer-Cabot met this set of requirements by developing a special version of the Holtzer-Cabot RBC – 2505 motor, which is now giving excellent service.

This is just another example of Holtzer-Cabot's ability to meet the most demanding specifications in small-motor applications. Holtzer-Cabot motors range from 1/2000 up through 1½ H.P.; from 12,000 RPM to 1 revolution per day!

*Reg. U. S. Pat. Off.

HOLTZER-CABOT

DIVISION OF NATIONAL PNEUMATIC CO., INC.

BOSTON 19, MASSACHUSETTS

"Manufacturers of fine electrical apparatus since 1875"

He Sparks
The wide diversity, and relative complexity, of the equipment we manufacture puts a premium on advanced and alert engineering. In designing top performance, dependability, and economy into the wide range of Baldwin-Lima-Hamilton products, our entire design-engineering staff finds PRODUCT ENGINEERING a highly important source of alert, forward-looking ideas.
John S. Newton
Vice-President, Engineering
Baldwin-Lima-Hamilton Corporation
Eddystone Division
THE MEN WHO DESIGN

Product-Design at Baldwin-Lima-Hamilton

HE READS PRODUCT ENGINEERING

***Everywhere* in the giant ORIGINAL EQUIPMENT MARKET* . . .**
PRODUCT ENGINEERING will help you find *bigger markets* for your products

Win acceptance and preference for your parts, materials, components, or finishes in industry's Design-Engineering Headquarters . . . and you have won acceptance where the buying decisions are made in your biggest and most concentrated of all industrial markets.

These Design-Engineering Headquarters spark the development of every machine or other engineered product industry manufactures: at least $100 billion worth this year. And as a basic part of their job, the engineering executives in these Headquarters are selecting and specifying $26 billion of ORIGINAL EQUIPMENT* in 1951.

This tremendously big and concentrated market offers exciting rewards to sound selling . . . the kind of selling which starts and keeps momentum best on the firm base of concentrated advertising in PRODUCT ENGINEERING.

This is the magazine, above any other, which can sell for you in industry's Design-Engineering Headquarters . . . with peak impact and minimum waste. Alone among all magazines edited for them, this is the magazine product-design engineers pay to read. And the facts about PRODUCT ENGINEERING's 18,000 management-concentrated, design-responsible subscribers are facts you can't afford not to know.

These facts are available, quickly and concisely, from your PRODUCT ENGINEERING representative. For a head start on making next year the best in your sales history, call or write him today at any one of the McGraw-Hill offices listed below.

PRODUCT ENGINEERING

ABC ABP

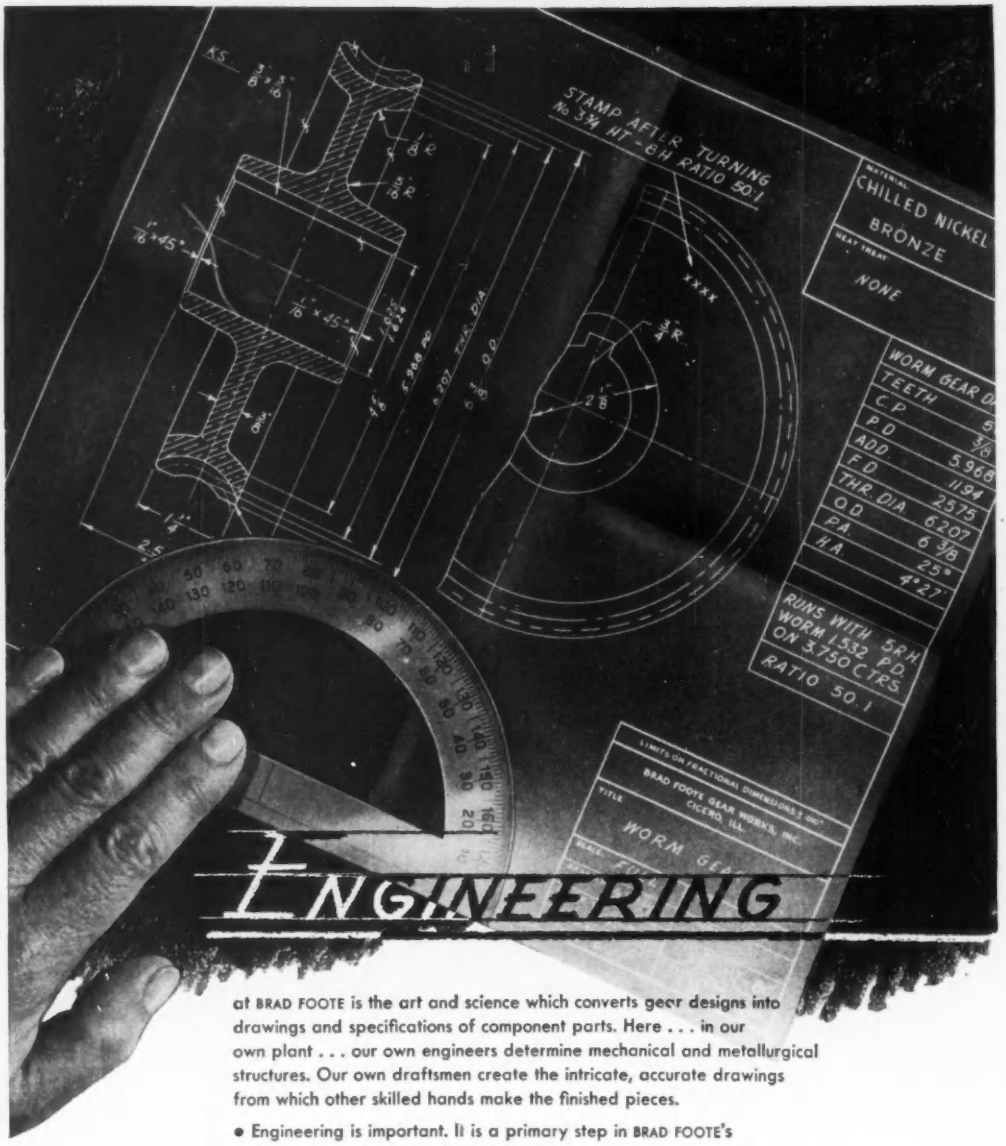
A McGraw Hill Publication
McGraw-Hill Building, New York 18

DISTRICT OFFICES: Atlanta 3 • Boston 16 • Chicago 11 • Cincinnati 8 • Cleveland 15 • Dallas 1 • Detroit 26 • Los Angeles 17 New York 18 • Philadelphia 3 • Pittsburgh 22 • San Francisco 4

PRODUCT ENGINEERING CARRIES MORE ORIGINAL EQUIPMENT* ADVERTISING THAN ANY OTHER MAGAZINE IN THE WORLD!

*When your parts, materials, components or finishes are selected by product-design engineers for incorporation in new machinery, equipment or appliances . . . they are specified as *Original Equipment*. The *Original Equipment Market* is the big-volume, repeat-order market which offers any supplier of parts, materials, components or finishes industry's biggest sales opportunity. And advertisers place more advertising pages, and invest more advertising dollars, in PRODUCT ENGINEERING than in any other design magazine in the world because they know PRODUCT ENGINEERING gives them top coverage of the *Original Equipment Market's* basic buyers at lowest cost.

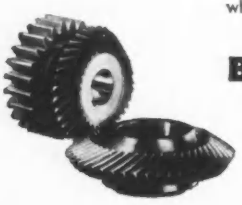
AMERICA'S NEW PRODUCTS READ PRODUCT ENGINEERING



at BRAD FOOTE is the art and science which converts gear designs into drawings and specifications of component parts. Here . . . in our own plant . . . our own engineers determine mechanical and metallurgical structures. Our own draftsmen create the intricate, accurate drawings from which other skilled hands make the finished pieces.

• Engineering is important. It is a primary step in BRAD FOOTE's method of complete manufacturing control. It assures you of gears which will perform satisfactorily . . . when used in your shop or on equipment you sell to others.

• This engineering service we give our customers is another reason why we can say—"*No one shares our responsibility.*"



BRAD FOOTE GEAR WORKS, Inc.

Bishop 2-1070 • OLympic 2-7700 • 1309 South Cicero Avenue
Cicero 50, Illinois

Materials ~ AVAILABILITY AND TRENDS

THE MATERIALS PICTURE

A new hunt for substitutes, a decline in basic metals for most uses, and an increasing shortage of components dominate the materials picture.

Government allocaters are preparing another round of metals cutbacks. The only products that are sure to escape are those for the military and AEC. Metals for everything else are likely to be slashed. Autos and other consumer durables are scheduled in preliminary plans for cuts up to ten percent. Only a top-level relaxation of the military program will change the outlook.

The NPA divisions that will cut the use of metals -- particularly steel, copper, aluminum and nickel -- are pushing plastics as alternate materials. In one sense this is a second round of substitutions. A lot of appliance makers, for example, have already shifted from zinc to aluminum. Now they are being urged by NPA to shift from aluminum to plastics.

NPA says the plastics outlook is good. Phenol-formaldehyde molding powders are expected to be fairly plentiful in a few months. Urea and melamine formaldehyde are in increasingly good supply for baking enamels.

Here are some consistent substitution trends as shown in reports to NPA: Steel for aluminum; zinc plating for cadmium and nickel plating; powdered iron for sintered bronze in wheel bearings; enamel for nickel plate; grey iron for aluminum; glass tubes for brass and copper tubes; porcelain enamels for stainless steel.

Among the alloys, boron is still the hottest substitute. Production of boron treated steel hit 25,000 tons in July, and is still rising.

COPPER SHORTAGE TO CONTINUE

Behind the new push for substitutes is a rapidly mounting military use of metals, with copper at the top of the list. Copper imports are still a third below last year, and the new international allocation agreement will not help much. There is no important domestic expansion of copper production in the works until 1954. Much of this will merely replace mines now being exhausted. Mobilizers dipped into the stockpile for 30,000 tons in October, but this did not replace the amount lost in recent strikes.

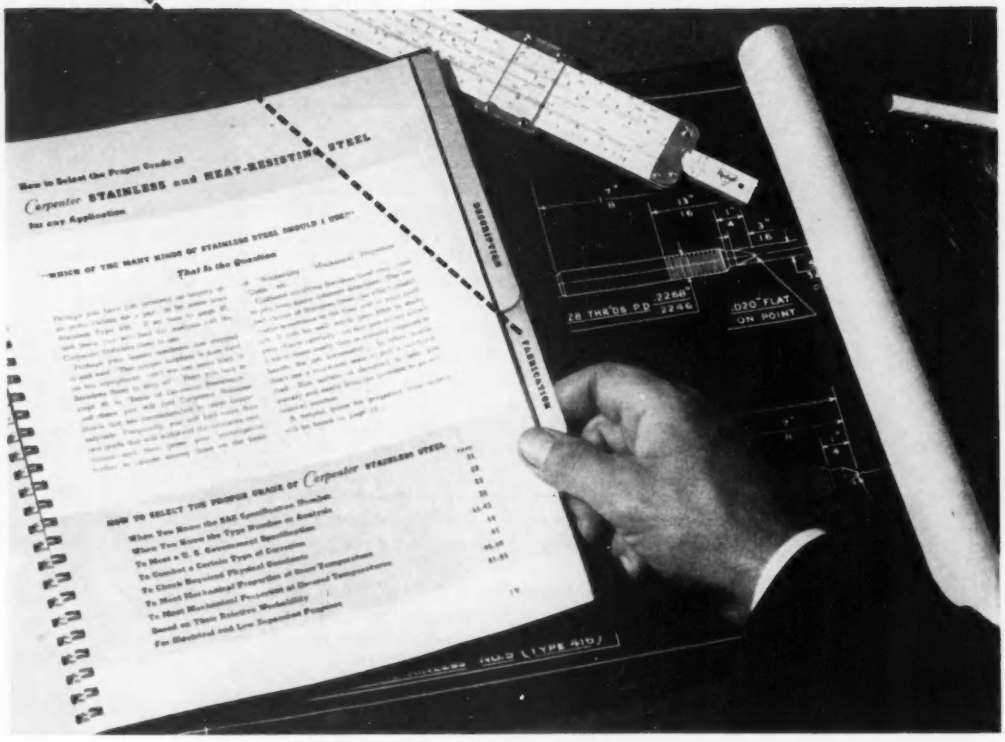
The use of aluminum in place of copper is being pushed by the allocaters. Top mobilizers are urging industry to design copper out of their products, with a ten-year picture in mind. One manufacturer of industrial electrical equipment estimates aluminum can replace forty percent of the copper in some products. Several firms are turning out fractional horsepower motors with aluminum windings. Aluminum wiring is also being used for some types of special transformers. One manufacturer is stretching his copper allotment ten percent by compressing motor windings for better condition.

NEW ALUMINUM CAPACITY

So far the power shortage in the northwest has not cut back aluminum seriously. By the first of the year, a new plant capable of turning out 100,000 tons a year will be in operation. The industry expects to move rapidly from a present production of 833,000 tons a year to 1,400,000 tons of capacity by July, 1953. Some of this will be for non-military uses, despite plans for increasing the Air Force from 95 to 130 groups.

(Continued on page 115)

X MARKS THE SPOT


How to Select the Proper Grade of
Carpenter STAINLESS and HEAT-RESISTING STEEL
for any Application
"WHICH OF THE MANY KINDS OF STAINLESS STEEL SHOULD I USE?"
That Is the Question
HOW TO SELECT THE PROPER GRADE OF Carpenter STAINLESS STEEL
28 THR'DS P.D. .2246"
.020" FLAT
ON POINT

Where You'll Find Answers to Your Questions about Stainless

We've taken our own experience in making Stainless—added a lot that we've learned about fabricating Stainless—and put it in this 133-page Working Data Book.

To put this book of combined experience to work for you, to get a greater number of perfect parts from every pound of Stainless you buy, call your Carpenter representative and ask for a copy of the Stainless Working Data Book. If you don't already have a copy, he'll be glad to give you one. And when you talk to him, put him to work on any special problems you may have. He knows a lot about Stainless. And he is backed up by mill men who have spent their lives digging for ways to do Stainless jobs better.

Make full use of Carpenter's service to users of Stainless. Call your nearest Carpenter office today for a copy of "Working Data for Carpenter Stainless and Heat Resisting Steels" . . . or for personal attention to a specific problem.

The Carpenter Steel Company, 117 W. Bern St., Reading, Pa.
Export Department: Carpenter Steel Co., Reading, Pa.—"CARSTEELCO"

Carpenter
STAINLESS STEEL
takes the problems out of production

For help with Stainless problems Call Carpenter. Warehouses in principal cities throughout the country.

STEEL OUTLOOK

Some forms of steel are getting easier to obtain. Authorized CMP orders for tinplate, cold rolled sheets and shapes seem to be in fairly good balance with available supply. But some users of bars and hot rolled sheets still can't find mills to accept orders.

Nickel-bearing stainless will be scarcer next year. Military demands for nickel are ballooning and there's no relief in sight until late in 1952. Chrome steels, however, look promising. They are now in good supply and mill capacity is greater than current usage. Fourth quarter allocations were increased to many industries. The outlook is for bigger allocations in the first and second quarters.

LEAD AND OTHER METALS

Lead is rising toward the top of the hard-to-get metals, after being in fairly easy supply most of the first year of mobilization. Imports are the big trouble -- they are down sharply because foreign use can outbid U.S. ceiling prices. The two-cent price rise allowed by OPS won't help much. The lead squeeze is so acute that 7,000 tons have been diverted from the stockpile.

Zinc is becoming more scarce, and for the same reason. There is not much hope of immediate improvement unless an international allocation can be worked out to increase imports.

Supply of cadmium and bismuth has been eased, and controls have been relaxed. Antimony is in balance with supply and does not seem to be heading for serious trouble.

TIN AND RFC

Controls make tin scarce. The metal is plentiful on the world markets. There is a surplus this year, and another is expected next year, while RFC -- sole authorized buyer in the U.S. -- argues with Bolivian producers over price. During the negotiations, the RFC is selling its reserve stocks to U.S. industry. When these reserves are exhausted the producers think they can make their own price stick. The deadlock makes tin a risky metal to plan on, even at current low consumption. If the price negotiations fail, the government may cut consumption again rather than pay a higher price. Top tin people in the government figure the country can get along with much less tin than we are now using. The use of protective plastic coatings by the canning industry in lieu of tin plating will continue to be encouraged.

INDUSTRIAL COMPONENTS

Components are going to become increasingly scarce because of military demand. Valves and fittings, in particular, are a danger area, though they have been fairly ample to date.

Specialty transformer makers say their fourth quarter allotment of materials will fill only half of their defense-rated orders, which in some cases represent up to ninety percent of output. Delivery schedules are lengthening up to a year for some specialty transformers, compared to two months before the Korean War.

Lead time for power transmission chain is four to twelve months, compared to about a month normal delivery time before Korea. Some producers are working entirely on military orders, and the industry-wide percentage is climbing. Fourth quarter allotments are insufficient to fill all military and other essential needs, manufacturers told the National Production Authority.

Output of precision springs is down fifteen to thirty-five percent under last year due to materials cut-backs. Deliveries are running eight to twelve weeks behind orders.

A lead-time of fifty weeks has been reported by one user of forty and fifty hp motors. Gear reducers, small motor control switches and pumps are also getting harder to obtain.

Etling opens the window to GREATER PROFITS

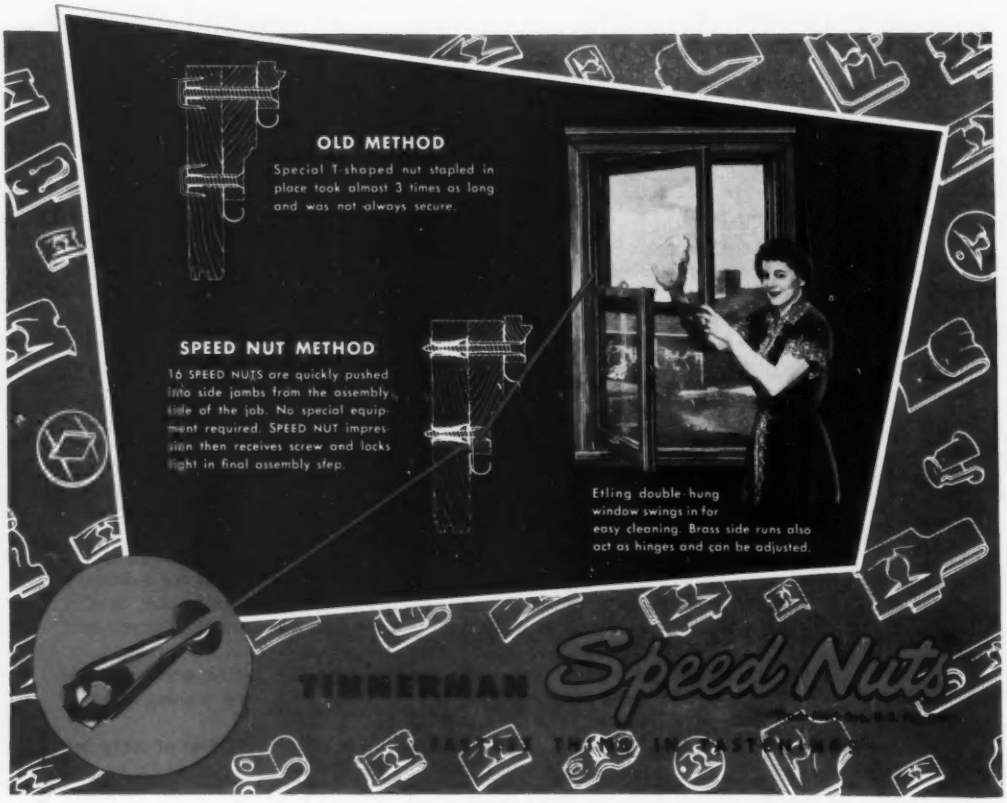
Here's how Weatherseal, Inc., cut costs 43% in jamb assembly of Etling In-Swinging Windows

● The ingenious Etling in-swinging window short-cuts the tedious, sometimes dangerous, chore of washing windows.

Etling and Tinnerman engineers put their heads together to determine a quicker way to fasten the side jamb assemblies. RESULT: *Not only did the 16 SPEED NUTS specified replace 32 other fasteners, they also eliminated the need for $3600 worth of assembly equipment, and broke an assembly line bottleneck. All this added up to a handsome 43% savings in the cost of assembling side jamb sections.*

Weatherseal also reports that product quality was greatly improved and assemblers picked up speed which ultimately put more dollars in their pay envelopes.

Perhaps you are seeking short cuts that pay off like this. Just indicate your interest by calling in a Tinnerman representative or writing us for information on our comprehensive Fastening Analysis Service. Also ask for your copy of "Savings Stories," factual case history booklet. TINNERMAN PRODUCTS, INC., Dept. 12, Box 6688, Cleveland 1, Ohio. In Canada: Dominion Fasteners Limited, Hamilton. In Great Britain: Simmonds Aerocessories, Limited, Treforest, Wales.


OLD METHOD
Special T-shaped nut stapled in place took almost 3 times as long and was not always secure.
SPEED NUT METHOD
16 SPEED NUTS are quickly pushed into side jambs from the assembly side of the job. No special equipment required. SPEED NUT impression then receives screw and locks tight in final assembly step.
Etling double-hung window swings in for easy cleaning. Brass side runs also act as hinges and can be adjusted.
TINNERMAN Speed Nuts

Only The Profit Motive Can Do It

IN A DEMOCRACY, progress stems from the ambition of the individual to reap a reward for the work, hardships and sacrifices he endures in creating or making available new or improved products and services. Applied to business, this philosophy has been labeled the profit motive. The profit motive applies equally well to individuals. It is the profit motive that impels the young man to devote many years to further education, the pursuit of knowledge and the development of skills in order that he may reap the rewards in his later years.

Under dictatorship an individual's incentive is to avoid hardships and punishment; under a democracy his incentive is the expectation of reward in recognition and better living.

Today industry and government are highly disturbed over the shortage of trained engineers. The basic reason for the situation is simple. The engineering profession is not sufficiently attractive economically. The motivating forces that attract individuals to a career are not sufficiently strong to induce enough men to take up the profession. Many young men conclude that the prospects of profit are not enough to warrant making the necessary sacrifices to achieve the position of a professional engineer.

Many figures are quoted to show that the engineering college graduate today receives a starting salary many times that of forty years ago. But it must be added that laborers and mechanics are being paid many times as much today as they were a few decades ago. Likewise there has been a commensurate rise in the cost of living.

Perhaps the principal factor that is not sufficiently recognized is that today an engineer must be far better equipped in knowledge and experience than was required of him forty years ago. Indeed, the value of the undergraduate degree has shrunk. Industry is demanding men with masters' degrees, to obtain which requires additional years of sacrifices. In many engineering positions a doctor's degree is essential. These additional sacrifices required to achieve the status of an engineer are not reflected in the monetary rewards obtained immediately after graduation.

Unfortunately, in assaying the problem too much emphasis is being placed upon the lucrative salaries received by the relatively few men in the highest brackets. More thought must be given to encouragement in the lower and middle levels.

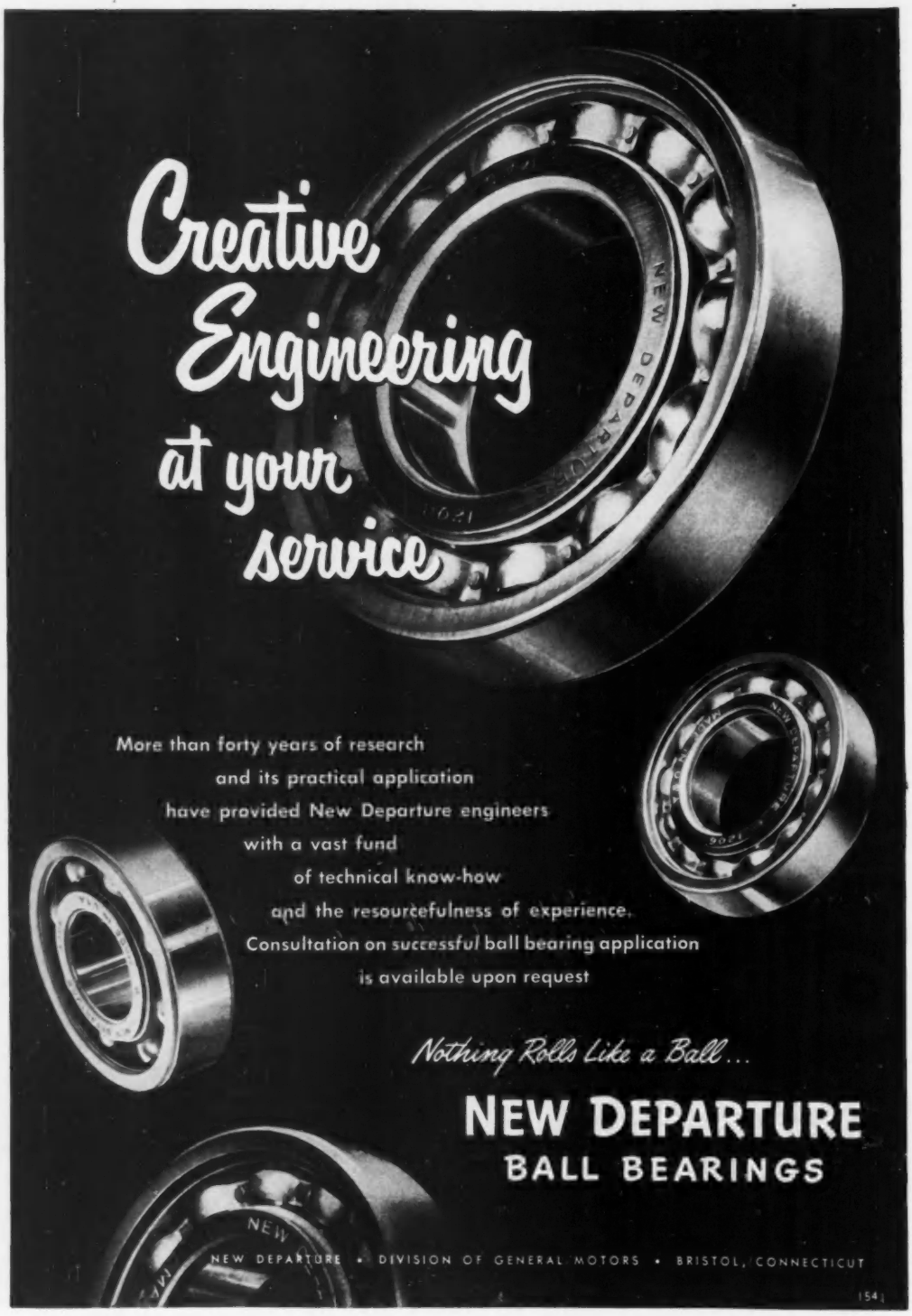
After receiving his degree the engineer can only look forward to a decade of struggle during which he is constantly preparing himself to take on major responsibilities. The time is long and the compensation and progress during that period is low and slow.

It is reported that Russia is graduating thirty thousand engineers annually with MS degrees. It is being done in the usual Soviet manner. It would be naive to underrate the quality and effectiveness of these men. Our own military men will, in the proper atmosphere, concede that Russian military equipment is in some instances superior to our own.

The outcome of the possible conflict we are now facing will be determined entirely by the relative quality of the engineering abilities of the opponents. As the world's only hope for the preservation of individual freedoms, this country cannot afford to take unnecessary chances on the superiority of American industry, science and engineering.

We cannot use the Soviet system to develop engineers. The United States must remain democratic and the only way it can do so and solve the engineering manpower problem is to recognize, subscribe to and exploit the profit motive as it applies to the individual—and business as well.

G. F. Jordenholt


Creative Engineering at your service
More than forty years of research
and its practical application
have provided New Departure engineers
with a vast fund
of technical know-how
and the resourcefulness of experience.
Consultation on successful ball bearing application
is available upon request
Nothing Rolls Like a Ball...
NEW DEPARTURE
BALL BEARINGS
NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT
154

Pleasant working surroundings do much to promote the engineer's self esteem, enthusiasm, and thinking and encourage creativeness.

Starting the Graduate Engineer in Machine Design

Suggestions for encouraging engineering graduates to begin their careers in the drafting room. Orientation of young graduates in a new environment. Importance of the functions of the drafting department as related to engineering. Department's personnel and operations. Rewards for those who make machine design their profession.

WILLIAM L. GOVAN

TO ENGINEERING MANAGEMENT, the scarcity of senior mechanical engineers with wide drafting experience is serious. Management desperately wants to know why it is that not many graduates begin their careers in drafting rooms. Why many of those who do, hardly stay a reasonable length of time? Why, unfortunately, of those who stay are some content to become and remain detailers?

The graduate has several stock reasons to explain why he avoids drafting room work like the plague: Salaries of engineers are low in comparison with those of salesmen and production managers; the fear of never getting off the drawing board; the feeling that drafting room work is a dead-end; the work does not require a graduate, but can be done better by a shop trained draftsman; and that the graduate seldom reaches a top executive job by way of the drafting room.

Possibly, the graduate who is attracted to the drafting room because of an interest in technical matters is not the type most suitable for top executive positions, which are basically

non-technical. Technical competence by itself is not well rewarded. Mechanical knowledge must be backed up by financial acumen and experience in dealing with people to make the completely satisfactory executive in mechanical industry.

A few years ago when newly employed, the recent graduate was paid on the basis of what his work was worth in comparison to that of other draftsmen. Today, company policy has changed in his favor. He is now paid at a more or less standard rate on the assumption that his value will improve rapidly. Thus today's graduates while more highly paid cannot expect their earnings to increase as quickly as they would have in the past. It is noteworthy to observe, however, that engineering salary increases over the last decade have been proportionately higher in the lower brackets than in the upper ones.

Personal Satisfactions

While other satisfying answers to these questions may not be obvious it is evident that to be successful, any management program for increasing the present supply of experienced machine designers must be oriented about one fundamental objective. That is: The personal satisfactions derived from time spent in the drafting room must be such as to foster the ambitions of young men to do creative, intellectual, and challenging work; not just to earn a living.

The details of procedure in a program to achieve this objective, of course, must differ from company to company. For its program to be successful, however, each company must make an effort to become acquainted with the designer's work and the talent required to perform it.

Machine design is not a science; it is the art of producing a design or drawing of a new machine or of a new component of a machine. Every line on such a drawing requires conscious thought and planning by the designer. Few lines on a drawing are dependent on mathematical stress calculations.

This reality is a sobering influence on the graduate beginning a career in design. He is accustomed to associating the term "machine design" with the substance of textbooks that deals almost solely with mathematical theory. As a novice designer, he finds himself in competition with draftsmen who started to learn their trade while he was still in his first years at high school. Such draftsmen often have the benefits and advantages of some shop experience, technical school training, night classes, correspondence school courses and a fairly wide reading of technical books and magazines.

At this point the graduate, with some justification, may lose all desire to become a senior mechanical draftsman, unless management assures him that they will give him ample opportunities to learn through practice how to develop speed and skill in producing a design of good proportions, an eye for readily detecting critical sections and out of balance designs, and a sense of rightness that makes minor calculations unnecessary. In addition management must convince him that their training program is designed to help him acquire imagination, know-how and skill in devising ingenious movements and devices; and also to obtain a practical knowledge of materials, production methods, foundry techniques, drawing office procedure, and local idiosyncrasies.

Such a program does not mean that the engineering training received at college is wasted. It simply means that the graduate as he progresses in his career must blend knowledge gained through practical experience with his previous theoretical training.

Design Result of Team Work

In a well balanced training program, graduates should be taught that design is the result of team work based on years of past effort by a multitude of designers. That there are trends and fashions in machine design, but few revolutions. Self-confidence is an advantage, but the starting point of any new design is always to consider the work that has already been done. Machinery and machinery details have been evolved by generation after generation of clear thinking designers, and tested by actual production; and are not likely to be improved overnight by the novice designer whose greatest asset is an unbiased mind.

There are actually few completely new designs. Existing designs are often added to or existing sub-assemblies regrouped; a new size or capacity is added to a line of existing designs; or details are altered for cheapness, to improve performance, to suit new methods of production, for better appearance, for more sales appeal by modernization, or for the inclusion of new ideas such as electronics or hydraulic controls. Hence the designer almost invariably has an abundance of old designs to use for reference, together with photographs, and as many publications and catalogs of competitors as he can amass.

The usual steps in design are somewhat as follows.

The idea for a new design is laid down or approved by company policy or management. Suggestions may have been made by potential customers, by a suggestion scheme, by the sales, development or research department, by an independent inventor, by the engineering department, by an interdepartmental development committee or even by the designer on the board.

The chief engineer or chief designer usually enlarges on the basic idea and prepares a few simple freehand sketches. The designer drafts preliminary design assemblies and sketches for estimating purposes or for approval. To assist him the designer has the preliminary sketches, specifications, minutes of committee meetings, verbal explanations, and all the references he can obtain. He makes or checks calculations on capacity, loads, power, time cycles, key dimensions, and key stresses. Drawing work and calculations alternate as the job progresses.

When approval is received the design is completed. Enough assembly and subassembly drawings are prepared by the designer so that every detail can be drawn by draftsmen without any ambiguity as to the designer's intention. The distribution of work between designers and detailers depends on local custom, on the skill and intelligence of the detailers, and on the novelty of the design. Certain complicated detail drawings may be made by the designer himself to be sure his ideas are correctly interpreted. On the other hand, a detailer familiar with certain components can prepare similar drawings if he is given a few key dimensions.

Shop foremen or supervisors, production engineers, or tool and process or planning department staff are called in from time to time to discuss production problems on the new design. How thoroughly this is investigated in cooperation with the shop depends on the quantity to be produced, the novelty and complexity of the design, local procedure, and the competence of the designer as regards knowledge of production techniques. It may vary from one or two telephone calls to a complete study of every operation by the tool and process department, and even to the manufacture of a prototype to check tooling and production methods. This prototype may be made of cheaper materials than the final design.

Management can start the graduate's design experience in no better place than in a design department that works closely with the shop. To see one's designs appear in metal and to see them work is a heart-warming experience. No matter how perfect the drawing seemed, the designer will

GRADUATES' REASONS WHY THEY AVOID DRAFTING ROOMS

1. Salaries of design engineers are low in comparison with those of salesmen and production engineers.
2. If once started they will never get off the drawing board.
3. Drafting room work is a blind alley.
4. A top executive job is seldom reached by the way of the drafting room.
5. Design engineering is a monotonous grind of mathematics and detail work.
6. Job has no prestige, no glamour, no social life.
7. Work is too confining, few outside contacts.
8. Sphere of interest is too narrow.
9. One mistake and your career is ruined.
10. Small reward and recognition for inventive talent.

SUGGESTIONS FOR GRADUATE TRAINING

OBJECTIVE: Personal satisfactions derived from time spent in the drafting room must be such as to foster the ambitions of young men to do creative, intellectual, and challenging work; not just to earn a living.

1. Pay at higher rate than draftsmen.
2. Plan the orientation of the young graduate in his new environment.
3. Make surroundings and working conditions pleasant.
4. Make a senior engineer responsible for training the graduate.
5. Have senior engineers show an interest in the juniors.
6. Don't make him an office boy.
7. Give problems that are of some importance.
8. Explain assumptions in making calculations.
9. Encourage the collection of engineering codes, standards, and simplified calculations.
10. Give him a chance to see his designs grow in metal, and to hear shop and customer criticism.
11. Give him opportunities to develop speed and skill in producing a design.
12. Help him acquire a practical knowledge of materials, production methods, foundry techniques, and drawing office procedure.
13. Acquaint him with the problems of shop foremen, production engineers, and planning department staff.
14. Explain market and customer's preferences, the company's sales policies, in so far as they affect design and product performance.
15. Send him out on field testing, installation and service work.
16. Commend him for work well done.
17. Pay tuition fees for post graduate work.
18. Encourage him to take pride in his professional standing.
19. Pay fees and travelling expenses to attend technical society meetings.
20. Provide technical magazines and books.

always find some improvement possible when the part is actually made. In addition, he will hear plenty of criticism from the shop, from the customer and from others.

When the drafting room is not connected with any manufacturing shop, designers and engineers tend to become a shade on the academic side. There are some drawings produced by even top rate consultants, for example, that cannot go straight into production without some modification by the manufacturer. And in these instances, shop criticisms are rarely passed back to the designer.

In many companies the design department staff act as field engineers in testing, installation and service work, and as assistant sales engineers on large contracts. All this outside work can be extremely beneficial to the graduate. Should any of these outside contacts pass back a word of commendation, the firm should always inform the graduate concerned. Management's neglect of even such a simple matter can cause an untold amount of frustration, for the grapevine has a way of finding out and reporting all such happenings.

Confusion in training program objectives can be caused by loose use of the word "design". It should not mean layout work. Layout work is largely the making of installation plans, piping and wiring diagrams, and collecting and using catalog data. While time-consuming and an exercise in accuracy, and often required of consultants, it is not truly mechanical design. Tool design also is excluded; it is a specialty on its own based largely on empirical methods and experience.

There are two main fields of design, although there is every shade in between, and their differences greatly affect the training of novice designers. The first is for limited production, for jobbing work, or for the custom-built trade. The second is for mass production.

The factor of safety is large for small production, because the manufacturer cannot afford to have even one failure, whereas with large production the occasional "lemon" is readily absorbed.

Overhead must be held to a minimum in small production, hence design and drafting room time must be kept down. It is cheaper to use extra material to be safe when only a few parts are required than to spend many additional hours in complicated calculations and analytical investigations.

Small production cannot afford models, extensive testing and prototypes.

Small production must design for the use of standard materials and standard sizes. Mass production can call for unusual materials, extrusions, special rolled shapes, extensive dies, patterns, and molds.

Design for small production must count on standard tooling as far as possible, with a minimum of special tools, gages and fixtures. Even some hand fitting is permissible.

For small production the design need not be so exact as that for large, since methods of manufacture usually permit minor changes and improvements right up to assembly. This procedure is often cheaper than making exhaustive studies.

For small production, manufacture may start as soon as preliminary drawings are completed. Mass production usually has a considerable time lag between completion of design and start of manufacture, often a prototype is made.

For mass production alternative designs may be completed prior to deciding on the best.

For small production, design may

be supplied or suggested by the customer, or based on customer's requirements. Competitive estimates are usually prepared by several firms on preliminary design, and if the price is satisfactory to the customer, designs are completed by the chosen contractor. Designs may change at this stage, provided the cost is not increased nor the specifications altered.

For mass production the manufacturer usually has more to say in the design than the customer. Design is modified more for economical production than for cheapness in itself. A final estimate may not be prepared until after the manufacture of a prototype. In many instances, selling price is not so directly connected with cost price as in those for small production, since no other firm is in competition on exactly the same design.

Judgment and Mathematics

When it comes to calculations the graduate must be taught that judgment is of as much importance as mathematical skill. He may learn the hard way, by having whole pages of calculations thrown out, not because the mathematics could be proved wrong, but because the resulting drawing just did not look right to his boss. And nine times out of ten the boss may prove to be right.

Simple members for compression, tension or flexure that would be straight-forward in structural work are almost invariably complicated in machine design. Assumptions have to be made to cover unknown fixity of end connections, curvature, stress raisers, fatigue, distribution of load, displaced neutral axes, type of loading discontinuity, and indeterminate size of effective load carrying metal.

Ability to make reasonable assumptions can be developed only by training and a sort of instinct towards a design. An approximate calculation based on good assumptions is better than a complicated calculation based on poor assumptions.

The frame of a jaw crusher, for example, consists of a rectangle with a spreading force on the two ends. Each end can be considered a simple beam freely supported and the sides can be considered tension members. Obviously, however, if the ends are considered beams with fixed ends, the bending moment in them is reduced and some moment is thrown into the sides. The problem is further complicated by varying cross sections, discontinuity and offset neutral axes. A designer will solve this problem in minutes by assumptions that reduce the whole problem to a few simple equations. A stress analyst will bring in a solution in a week or so and explain that he is not too happy about certain assumptions he also was forced to make.

Except in a few fields where stresses are unavoidably high, such as in high pressure hydraulic work, in aeronautical design where lightness is essential, and in mass production where every ounce must be saved per part because it totals into tons, the designer finds his calculations becoming more and more by rule of thumb. They are made even more so by repetitive work, for which codes or set methods of calculation have been set up by the company itself or by various associations. For example, the A.G.M.A. codes for gear design; and the A.S.M.E. codes for boiler design, and pressure vessels.

To understand these codes an engineering training is required, but to use them a legal rather than a technical mind is an asset. Any draftsman can make the calculations. In addition, the designer soon collects tables of load carrying capacity of springs, antifriction bearings, sleeve bearings, bolts, flanges, pipes and cylinders.

Designer's Status and Prestige

To attract more graduates to begin their engineering careers by way of the drafting room, management can do much by recognizing the intense interest most designers take in their work, and the loyalty they feel towards their designs and the ethics of designing. Designers will be just as loyal to the company when their pay is reasonably good—and no designer expects to become a millionaire—and when they are given a status and prestige commensurate with their contributions to the success of their company.

Graduates, like everyone else, are drawn to careers where they can enjoy their work and surroundings. The recent graduate is a young man of intelligence and ambition, even though he may be naive and green. He must not be treated as if he is an overpaid office boy. His dexterity with the slide rule and his knowledge of mathematics may be utilized, but not merely as if he were a calculating machine. Simple arithmetical problems of areas and weights may be his lot, but they should be interspersed with problems of some engineering complexity to build up his sense of importance.

Management should see that the graduate has competent supervision to give him advice and counsel, and to prevent mistakes from leaving his board. It is true that one can learn by one's mistakes, but when these are carried into production it is a slow, expensive and heart-breaking method of education. A senior engineer should assign problems to him so that he feels he is on important work for the company. He must not become or be made to feel subordinate to every draftsman in the office.

Senior engineers on the staff should try to remember the engineering college spirit and welcome the newcomer with camaraderie. The graduate should be made to feel at home and free to approach at least one older engineer for personal or technical advice.

Letters of Reference

The graduate's hiring, advancement and firing should not be controlled by a non-engineer. His title should indicate in some way that he is a graduate engineer, no matter how junior. He should be encouraged to take pride in his professional standing, and should know that his letters of reference will indicate that he was an engineer doing engineering work, not a draftsman or a technician, should he ever seek employment elsewhere.

It is amazing how a man will appreciate it if his employer spends a few dollars for his instruction, entertainment or comfort. Such attention will be remembered far longer than if the same trivial sum were added to the man's annual salary as a wage increase. It is human nature to welcome gifts more than cash, especially when the gifts are items normally regarded as beyond one's means.

A company reaps dividends when it pays tuition fees for correspondence courses, evening classes, university extension classes, part time post graduate work, text books, instruments, periodical subscriptions, and membership dues in technical societies, provided these all have some relationship to the job. Sufficient magazines should be distributed so that all those interested have a chance to read them while they are reasonably new. A technical library and reading room is a sound investment.

With the cooperation of other firms in the district, the company can sponsor local or branch technical societies, arrange meetings and invite prominent speakers. Technical films are always an attraction. Trips for groups or individuals can be arranged to other firms, either during or after office hours. It is a break for a young graduate to be sent out on company business—even if it is only a visit to another department or the shop.

But possibly the most effective methods of all for increasing the supply of mechanical engineers with drafting department experience is merely for management and the senior men to take a friendly interest—and show it—in the juniors and their problems.

Matching Torque Converters to Prime Movers

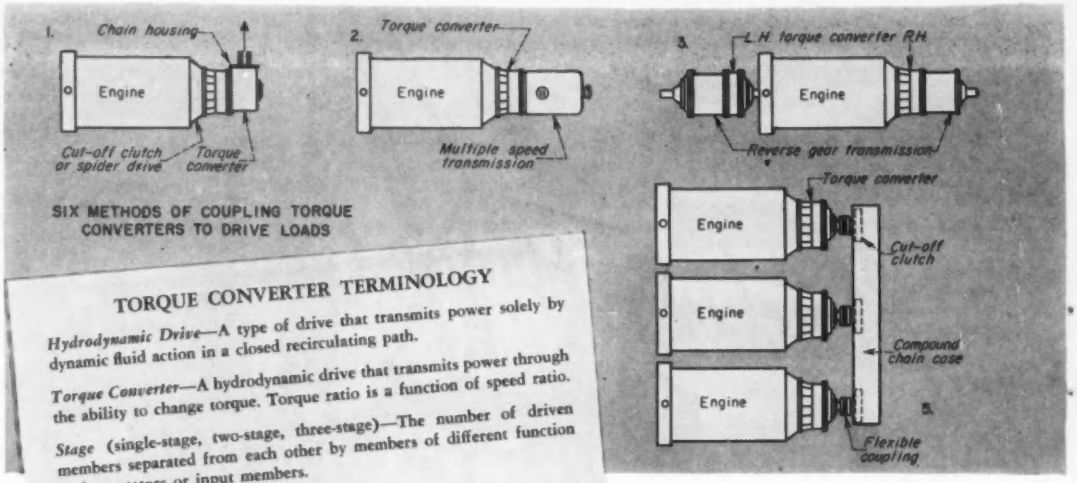
Positioning of huge bridge sections is simplified by a three-stage torque converter in this Clyde Iron Works hoist.

W. B. GIBSON
Hydraulic Division, Twin Disc Clutch Co.

THE APPLICATION of hydraulic torque converters to machinery, automotive or industrial equipment requires a thorough knowledge of converter performance characteristics and how these characteristics affect the prime mover horsepower and torque curves. While the performance characteristics of the various types of converters are generally similar (PRODUCT ENGINEERING, March 1950) each type converter has characteristics peculiar to its design. And it is these factors that the design engineer utilizes to obtain optimum performance for a given machine.

The three basic types of converters are described by the number of stages or sets of blades in the turbine wheel, namely, single stage, two stage and three stage. Single-stage converters produce from two and half to four times engine torque at stall, two-stage units from three to five, and three-stage assemblies from four and a half to six times the stall torque. Inasmuch as any given machine specification calls for a specified torque, line pull or tractive effort at some speed, the comparison between converters can be based upon equal stall torque where the low-torque-output unit is corrected upward torque-wise and downward speed-wise. Such a comparison, using identical engines, is shown in Fig. 1, which gives performance curves.

The first characteristic to compare is engine speed because this factor determines the horsepower input to the torque converter. The three-stage converter, when stalled, pulls the engine speed down lower than does the single-stage unit, thereby drawing more torque from the engine. Also, because of the lower engine speed, less horsepower is developed by the engine and less heat developed by the



SIX METHODS OF COUPLING TORQUE CONVERTERS TO DRIVE LOADS

TORQUE CONVERTER TERMINOLOGY

Hydrodynamic Drive—A type of drive that transmits power solely by dynamic fluid action in a closed recirculating path.

Torque Converter—A hydrodynamic drive that transmits power through the ability to change torque. Torque ratio is a function of speed ratio.

Stage (single-stage, two-stage, three-stage)—The number of driven members separated from each other by members of different function such as stators or input members.

Impeller—The power-input member.

Turbine—The output member.

Stator—The reaction member.

Specific Torque (M_s)—A rating used to distinguish between the torque capacities of converters in a given size.

Utility Ratio—The range of a converter between the 70 percent efficiency point at high sped to the 70 percent efficiency point at low speed.

Stall Torque Ratio—Torque ratio at stall of converter output shaft.

Overall Torque Ratio—The quotient of the stall torque ratio and the torque ratio at 70 percent efficiency in the high speed range.

three-stage converter at the stall point. Then, as the load decreases and the output shaft increases in speed, the three-stage converter permits the engine to speed up rapidly and develop increased horsepower. The single-stage converter generally reduces the engine speed somewhat throughout the accelerating range and then permits the engine to increase its speed slowly throughout the working range.

The second point of comparison is the gradient of the efficiency curve or the rate of rise in efficiency as the converter output shaft begins to increase in speed. Here again the three-stage converter more nearly suits the requirements for industrial applications. In comparing the efficiency of the two types, the single-stage unit becomes the more efficient as it approaches the high speed range. But the engine speed must be considered in conjunction with converter efficiency because the two together determine the efficiency of the "power unit package".

The third characteristic—output horsepower—is the important comparison because, in practically all industrial applications, the purchaser of a prime-mover is buying "horsepower". This comparison shows further that, for governed operation, the single-stage converter does not obtain hydraulic coupling performance because the coupling is too small. However, if the engine is permitted to operate at higher speeds, such operation can be obtained as shown by the extended engine speed and output horsepower curves in Fig. 1. A direct drive would be furnished with the three-stage converter for applications requiring high speed at high efficiency. Such a mechanical direct drive can also be furnished with the single-stage converter to produce identical performance.

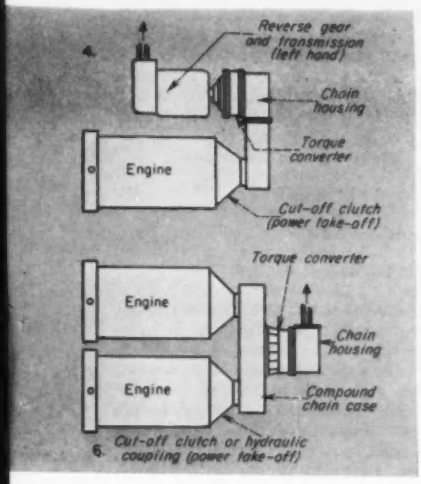
Two-stage converters have performance curves that represent a compromise between the one- and three-stage units in that the efficiency curve rises rapidly like the three-stage, but peaks further to the right similar to the single-stage. Engine speed characteristics of the two-stage converter are such that the engine is pulled down more at converter stall than with either the three- or single-stage units, and rises uniformly to full governed speed as converter speed ratio increases. This characteristic is desirable in road equipment because engine speed is more nearly "geared" to road speed. Both the single- and two-stage converters release or "freewheel" the stator blades at the high speed end of the curve, thereby unloading the engine at light loads. The three-stage unit keeps the engine fully loaded at all times.

Mechanical design of the two-stage converter is such as to permit the use of a single clutch for a direct mechanical drive, while the three-stage converter requires two clutches, one to release the converter from the engine, the other to connect the engine direct to the driven equipment. This setup requires a break in power flow, while the two-stage design provides continuous power flow for smoother and more safe operation.

Method of Rating

The capacity of a torque converter varies in several ways: The torque capacity varies in relation to the square of the input speed; the horsepower capacity varies as the cube of the input speed; and finally, both torque and horsepower capacity vary in relation to the fifth power of the pump or impeller diameter.

Because of the many different horsepower and speed ratings of industrial engines, arbitrary yardsticks for converter speed and size (diameter) have been adopted. Surveys show that a



speed of 1,700 rpm is the best average for the industrial engines available. With the speed reference point fixed at 1,700 rpm, the other variable —size—is then determined to provide the best coverage for the maximum number of engines available. The first size selected and produced by Twin Disc engineers had a capacity of 100 hp at 1,700 rpm. This unit was considered the base unit and the pump or impeller diameter constant taken as 1.0. With this as a standard, a unit 15 percent larger would have a diameter constant of 1.15 and therefore a capacity of 200 hp at 1,700 rpm, since 1.15 raised to the fifth power is *two*. Also available is a third size converter having a diameter constant of 1.6, which raised to the fifth power provides a capacity 10.49 times the base unit or 1,049 hp at 1,700 rev per minute.

Other manufacturers use different methods of rating. Some base the rating directly on fluid circuit diameters, while still others have established a series of model numbers, the key to which can be any one of several variables. Minor variations to the pump and turbine then provide a series of converters within a given size to cover a range of engine speeds and horsepowers.

The pump blades, which affect the volume of the fluid circulated, are normally used to obtain the necessary minor steps in capacity range to make a given size of converter suitable for respective engine speeds and horsepowers. The pump capacity can be changed, without altering the blade profile, by varying the number of blades or by increasing or decreasing the pump blade angle. In the case of a three-stage unit, increasing or decreasing the diameter at the tip of the blades can also be used. This last method is most commonly applied by first building the largest pump size and then turning down the completed pump assembly on the diameter to suit the requirements. The three-stage capacity range can be further extended by changing the length of the third stage turbine blade. Two turbine wheels are used, one with a long third-stage blade for the higher capacity units of a series, the other with a short third-stage blade for the lower capacity units. The two turbine wheels used with various pump diameters provide a series of several converters

Torque converters must, of course, be matched to the engine for full throttle governed speed operation at the point where maximum net horsepower is developed. It is common practice to have the converter absorb this power at a point where converter output torque is equal to the input torque or at the clutch point. Referring this relationship to the speed reference point of 1,700 rpm and to the diameter constant, the formula for torque capacity is

$$M_s = \frac{hp \times 5{,}252}{N_1}\left(\frac{1{,}700}{N_1}\right)^2\left(\frac{1}{D}\right)^5 \quad (1)$$

where M_s = specific torque, lb-ft
N_1 = engine or input speed, rpm
D = diameter constant (1.0, 1.15 or 1.6)

The specific torque, or M_s rating, within each of the three sizes as shown in Fig. 2, Horsepower Capacity Chart.

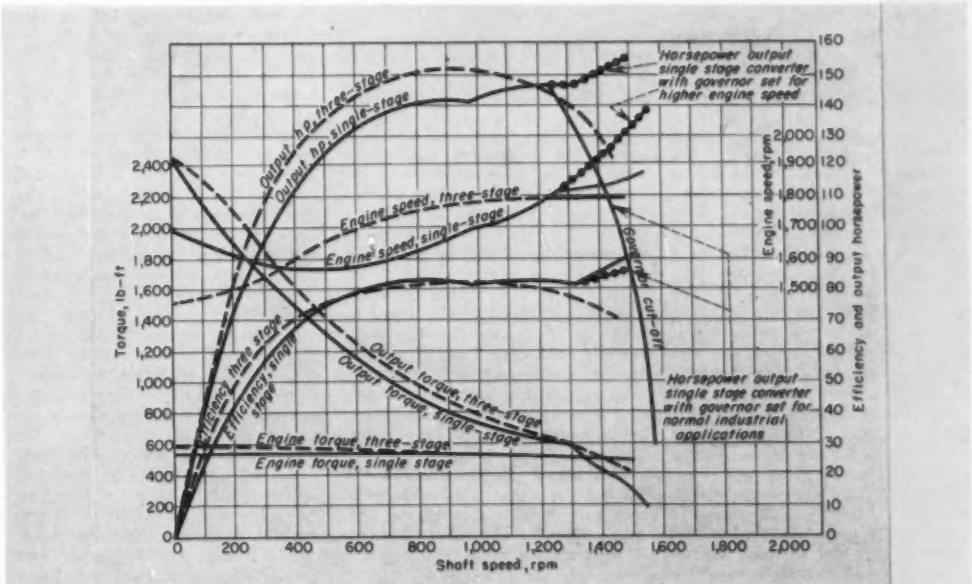


Fig. 1—Comparison of performance characteristics for single and three-stage torque converters.

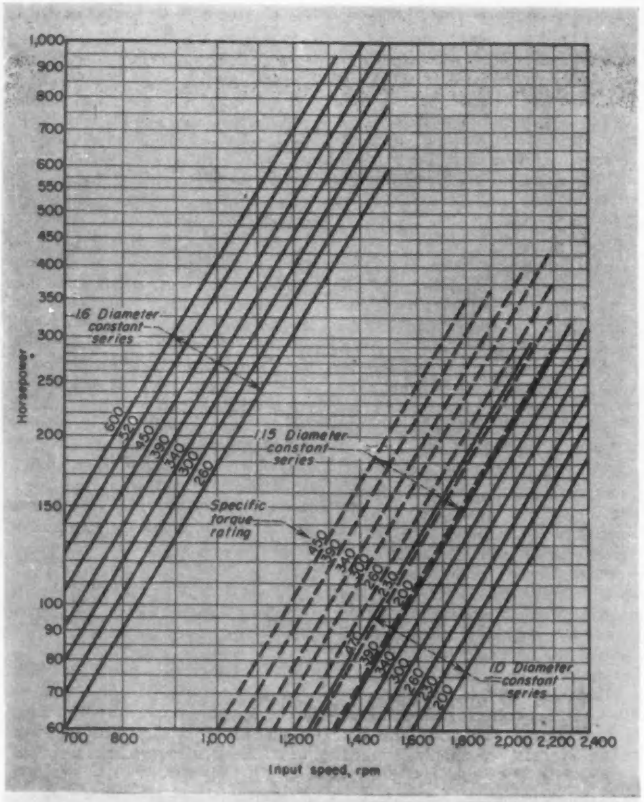


Fig. 2—Horsepower Capacity Chart for three series of torque converters. Intermediate sizes are obtained by varying the shape and number of impeller blades.

is used to distinguish each of the converters of a given size by torque capacity. Referring to Fig. 2, the base unit in each series has an M_s rating of 300 lb-ft. In the 1.0 and 1.15 size converters, this rating is the mid-point unit. In these two series, the long third-stage turbine is used in the units having a rating of 300 lb-ft or higher, while the short third-stage turbine is used in units below this rating. The 1.6 size converter contains the long third-stage turbine throughout.

Once the correct converter has been chosen for a given engine, a performance curve based on the primary torque curve for the converter selected is developed. Fig. 3 shows a primary torque curve for a 1.0 series converter rated at 390 lb-ft specific torque ratio.

Several important characteristics of the converter—the utility ratio, overall torque ratio and stall torque ratio —are derived from the primary torque curve. The utility ratio indicates the range of the converter between the two 70 percent efficiency points. The relationship is obtained by dividing the speed ratio at the high-speed 70 percent efficiency point by that at the slow-speed 70 percent efficiency, or, as in Fig. 3, for the 1.0 series M_s-390 curve, 0.73 divided by 0.215 or 3.40. The 70 percent efficiency points are used because the cooling normally provided with converters accommodates 30 percent of the converter capacity and continuous operation between these points does not cause overheating.

The overall torque ratio is the usable torque range of the converter and is obtained by dividing the stall torque ratio by the torque ratio at 70 percent efficiency in the high-speed range.

The torque ratio at 70 percent is not shown. It can be found, however, by dividing the efficiency at 70 percent expressed as a decimal by the speed ratio at this point, that is, 0.7 divided by 0.73 or 0.95 to 1. Therefore, the overall torque ratio is 5.0 divided by 0.95, or 5.30. The torque ratio can be obtained for any point on the curve from the formula

$$\text{Efficiency} = \frac{M_2 \times N_2}{M_1 \times N_1} \qquad (2)$$

which becomes

$$\text{Torque Ratio} = \frac{M_2}{M_1} = \frac{\text{Efficiency}}{N_2/N_1} \qquad (3)$$

where M_2 is output torque, M_1 is input torque, N_2 is output rpm and N_1 is input rev per minute.

The stall torque ratio is, of course, the torque ratio at stall of the converter output shaft. All engines will not pull down to the same input speed at stall, which means that the fluid flow will vary giving different stall torque ratios. Actual values are shown at the left in Fig. 3 for input speeds from 1,000 to 1,600 rev per minute.

One other important relationship is the exact M_s point for a given converter. Referring to the efficiency formula above, this point is the one at which the efficiency (expressed as a decimal) and speed ratio are equal. A quick method for locating this point on the primary curve is to connect the 0.6 speed ratio at 60 percent efficiency to the point at 80 percent and 0.8 speed ratio with a straight line. The intersection of this line with the efficiency curve locates the M_s point quickly and accurately.

Primary curves vary somewhat for each M_s converter within a given size series. Since the difference is progressive from the lowest to highest capacity units, it is possible to make a direct comparison between these two units as shown in Fig. 3. The primary difference is the overall range of the M_s-390 converter; the next is the slope of the primary curve. Wide variations of output shaft speeds will affect engine speed only slightly because of the flat primary curve of the M_s-390 converter, while the steep primary curve of the M_s-200 unit will have a more direct effect on engine speed. This steep primary curve can be useful in certain applications where cyclic high loadings are encountered as both pistons of a duplex power slush pump move toward the fluid end of the pump. The more abrupt pull-down in engine speed will add a greater value of flywheel ($W\ R^2$) effect to the input torque, resulting in a more uniform pump speed. Finally, a much higher stall torque is available from the lower capacity unit, that is: 5.85 for the M_s-200 unit; 5.0 for the M_s-390 unit.

Application to the Prime Mover

It has been shown that the primary curve represents the actual torque and speed values the converter will demand while under various operating conditions. Therefore, all calculations must be based on actual net power delivered by the prime mover.

Normal care must be exercised when using published engine horsepower curves to determine the basis of the curve. Frequently, three curves are shown—first, the bare engine less fan and other accessories; second, an intermittent duty curve; and third, a continuous duty curve. The first of these is most commonly supplied by engine manufacturers. Allowance should be made for altitude if high altitude service is anticipated because ratings are generally for 60 F at sea level. In the absence of definite information, it is safe to deduct 15 percent from the bare engine curve.

Selecting the Converter Size and M_s

For purpose of discussion, assume the problem of applying a converter to an engine that delivers a gross of 275 hp at 2,100 rpm and a net of 234 hp at 2,100 rpm. The size and M_s of the converter are figured from Eq (1). Substituting known values

$$M_s = \frac{234 \times 5{,}252}{2{,}100}\left(\frac{1{,}700}{2{,}100}\right)^2\left(\frac{1}{D}\right)^5$$

$$= 585 \times 0.656\left(\frac{1}{D}\right)^5 = 384\left(\frac{1}{D}\right)^5$$

Using the values 1.0, 1.15 and 1.6 for D, the diameter constant, the M_s values are 384 for the 1.0 series, 192 for the 1.15 series and 36.6 for the 1.6 series. Referring to the capacity chart, Fig. 2, two converters would be suitable, namely, M_s-390 in the 1.0 series and M_s-200 in the 1.15 series. The M_s-390 is generally selected for two reasons: First, lower cost, and second, because it is better practice to favor units of lower capacity to avoid applying a unit that is too large for the engine. However, if the driven equipment is to be the slush pump mentioned above, then performance will require the M_s-200 unit with the steeper primary curve.

The above method is accurate, but slow. Common practice is to use the Horsepower Capacity Chart, Fig. 2. Here again, 234 hp at 2,100 rpm falls just below the M_s-390, 1.0 series converter. Then the engine-converter package performance characteristic curve is plotted using the primary curve for the specific converter.

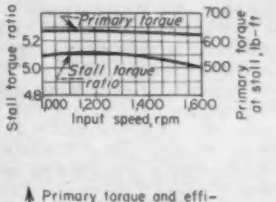
A	B	C	D	E	F	G	H	I	J
Engine rpm	Input rpm N_1	Engine Net hp	Input Torque M_1	Corrected M_1	Speed ratio N_2/N_1	Conv Eff	Output rpm N_2 (BxF)	Output hp (CxG)	Output Torque M_2 (From H & I)
	1,650	190.3	606	643	Stall	0	0	0	3,030
	1,700	196.4	606	606	0.085	0.390	144.5	76.6	2,785
	1,800	207.5	605	540	0.205	0.685	369.0	142.0	2,020
	1,900	216.7	599	480	0.315	0.790	598.0	171.2	1,503
	2,000	226.5	595	430	0.440	0.820	880.0	186.0	1,110
	2,050	231.0	590	406	0.600	0.796	1,230.0	184.0	784
	2,100	234.0	585	383	0.740	0.694	1,555.0	162.4	548
	2,100	227.0	568	373	0.800	0.610	1,680.0	138.5	432
	2,100	213.0	533	350	0.900	0.365	1,890.0	77.7	216
	2,100	201.0	503	330	0.995	0	2,090.0	0	0

Stalling Ratio M_2/M_1 = 5.0 to 1; stalling torque = 3,030 lb-ft

Fig. 4—Work sheet for data from which performance curves for a particular combination of engine and torque converter are plotted.

Engine-Converter Performance Curve

The first step in this procedure is to set up a columnar form as a work sheet. As shown, Fig. 4 is only the working portion of this sheet and



Primary torque and efficiency 1.0 series converter 390 lb-ft specific torque ratio. Utility ratio=3.40, stall torque ratio=5.05:1.0, overall torque ratio=5.5

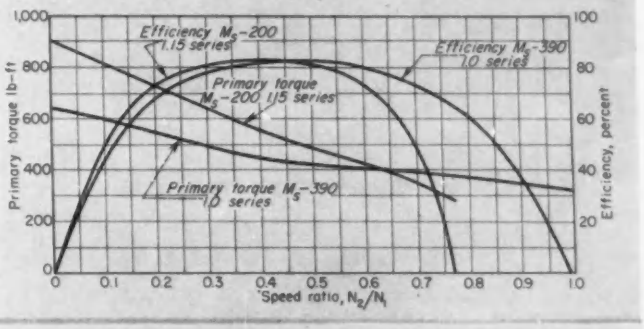


Fig. 3—Comparison of primary torque and efficiency curves for two particular M_s converters, series 1.0 and 1.15, respectively. Curves at left are for M_s-390 converter.

should be referenced to the make and model of engine used, the converter series and M_e rating and the primary curve number of the converter.

The columns are lettered from "A" through "J". Column "A"—Engine rpm, and column "B"—Input rpm, N_1 can be used interchangeably when the converter is mounted direct to the engine. In the event a slow speed engine is used or the engine speed and input speed are not the same, column "A" is used for engine speed and column "B" for true input speed (engine rpm times input ratio).

The second step is to determine the engine speed when the converter is stalled. The average pull-down in engine speed is approximately 20 percent, therefore the first estimate will be 80 percent of 2,100 rpm or 1,680 rpm. The net engine horsepower at this speed is 193.4 and the net torque 606 lb-ft. Since the converter primary curve is related to 1,700 rpm, the torque value of 606 lb-ft must be corrected as follows:

$$606\left(\frac{1,700}{1,680}\right)^2 = 606 \times 1.026 = 621 \text{ lb-ft}$$

Inasmuch as the primary curve indicates a requirement of 641 lb-ft at stall, more engine torque is required and therefore the engine will be pulled down further. After trying 1,650 rpm and 190.3 hp, the corrected engine torque becomes 643 lb-ft, a more accurate figure to use at the stall point. From this point on, increments of 100 rpm input speed are used in determining net engine power and torque, and in correcting the torque to 1,700 rpm primary speed. These points are selected up to the governed speed of the engine and set down in their respective columns, leaving space for intermediate points if needed later when plotting the performance curve.

Using the primary torque values in column "E", the converter speed ratio (N_2/N_1), column "F" and efficiency, column "G" can be determined from the primary curve in Fig. 3. With these data, values for columns "H" and "I" can be calculated. The primary curve provides the stall torque ratio, in this instance, 5.0 to 1. This value multiplied by the input torque, column "D", gives 3,030 lb-ft stall torque in column "J". The primary torque value shown in column "E" should not be used for this one point.

Engine-converter performance beyond the governed engine speed point is determined by working back from the converter primary curve. Selecting uniform speed ratio points such as 0.8, 0.9, and 0.995 (racing), the converter efficiency and primary torque values are obtained from the primary torque curve, Fig. 3. Since the engine will remain at 2,100 rpm, the net input horsepower can be figured from the formula

$$hp = M_i\left(\frac{N_1^3}{5,252 \times 1,700^2}\right) \quad (1)$$

Once the net input horsepower values for the points are obtained, the remaining data above are calculated.

In Fig. 4, there is a sizeable gap between output speed and torque for engine output speeds of 2,000 and 2,100 rpm. To facilitate drawing a smooth performance curve, a fill-in point for 2,050 rpm input speed is calculated. The data on the work sheet are then plotted to obtain the performance characteristics of the "engine-converter power package" shown as Fig. 5. This curve is for full throttle setting on the engine.

The shape of the output horsepower and torque curves in Fig. 5 are entirely different from those for the engine alone. A better conception of this difference can be had by direct comparison of the curves in Fig. 5. The full throttle power curve for the engine spans the range from 900 through 2,100 rev per minute.

The above engine-converter unit develops uniform power throughout a wider speed range. It also provides speeds from full stall to 1,560 rpm with a torque range of 5.6 to 1, while the engine above has a limited speed range of 2.3 to 1 with a unity torque range. The engine power speed range, when used with a converter, varies from 1,650 to 2,100 rpm, indicating no overloading of the engine.

In the event the efficient high power range of the engine is needed for high speed operation, the converter can be by-passed with a direct drive clutch. Here, the converter is used for acceleration and heavy loads and is cut out at 1,480 rpm output speed by the direct drive clutch. The power unit performance curve then becomes the combination of the two.

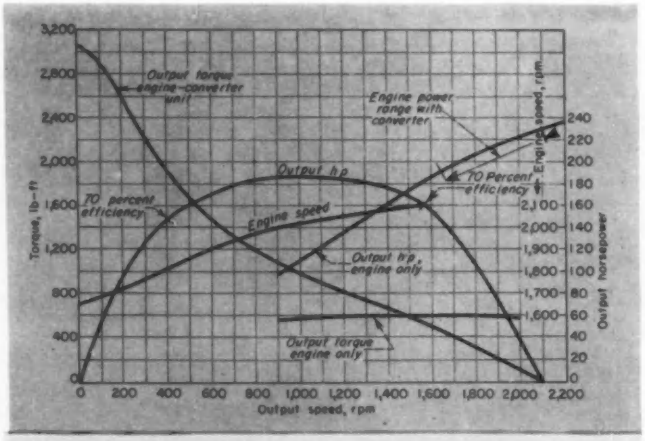


Fig. 5—Comparison showing how power and torque curves of a 275 hp, 2,100 rpm engine are changed when a series 1.0 M_e-390 converter is used.

Input-Output Torque Curve Method

In applications where specific output torque and speeds are required and engine throttle control is to be automatically controlled by governor to suit, it is necessary to have some means of plotting the desired output performance and from this to determine the prime mover requirements. The input-output torque curve method permits the development of a complete engine-converter performance curve by simple plotting. The only calculations necessary are those of obtaining the output horsepower from the output torque and speed values, and possibly the input torque from the input horsepower.

An input-output torque curve for the M_e-390 series 1.0 converter is shown in Fig. 6 with the sample engine performance plotted. The lower or input torque portion consists of a family of curves, each curve representing a specific and constant input speed. The curves are plotted against torque value as ordinates and output rpm as abscissas. A comparison of the 1,700-rpm curve, Fig. 6, with the primary

torque curve reveals the two to be identical except that the latter has "speed ratio" as the abscissa. The other curves are essentially primary curves, but related to their respective input speeds by the square law.

The upper or output torque portion of Fig. 6 consists of a corresponding family of curves, again each curve relating to the specific and constant input speeds shown below, but representing the output torque available at various output speeds. As mentioned above, for each speed ratio N_2/N_1, the torque ratio value can be determined by dividing the efficiency by the speed ratio. Therefore, the output torque curves in the upper portion represent the input torque curves below multiplied by the proper torque ratio for the corresponding output speed and plotted against output speed.

It remains then to project each intersection point of the engine torque curve with the constant input speed curves vertically upward along the output speed ordinate to the proper output torque curve corresponding to the constant input speed. For example, the engine torque curve intersects the 2,100 rpm input speed curve at 1,543 rpm output speed. This establishes the output speed. Then, projecting this point up to the 2,100 rpm curve in the upper portion, the output torque of 565 lb-ft is found. Similarly, the engine torque curve crosses the lower 2,000 rpm curve at 905 rpm output speed and projecting this to the upper 2,000 rpm curve, the output torque of 1,060 lb-ft is determined.

The same procedure is followed for 1,900, 1,800 and 1,700 rpm input speeds. Stall point cannot be determined in this manner, but at stall the input torque is 606 lb-ft. The stall torque ratio in this instance is 5.0 to 1, giving 3,030 lb-ft output torque at stall. A series of points for establishing the output torque curve is thus obtained. Inasmuch as the engine is governed at 2,100 rpm, the output torque curve follows the 2,100 rpm curve from 565 lb-ft at 1,543 rpm to zero torque at 2,090 rpm. The output horsepower is then calculated from output torque and output speed.

Each family of curves in Fig. 6 appears to be divided into three sections by two lines following a square curve. These square curves represent the two 70 percent efficiency points of the converter and continuous operation should be confined to the area between these two lines. This operating range on the output horsepower curve is found directly above or below, as the case may be, the 70 percent efficiency points on the output torque curve.

The input-output torque curve is truly a performance characteristics curve for the torque converter. Any partial throttle engine performance can be figured just as readily as the foregoing full throttle problem. Input speeds sufficiently low to permit calculations of output torque at engine idling speeds are included. Both input and output torque can be found if the input and output speeds are known. Further, if the output torque and speed are given, the input speed and torque values are immediately available.

In the two methods discussed, the converter is matched to the engine so that the peak governed horsepower input occurs at the M_s point or where converter output torque equals the input torque. Occasionally there are special requirements where it is desirable to match the peak engine power to the maximum efficiency point of the converter. This can generally be done by using the next smaller size converter and will produce higher output horsepower but at a reduced output speed. Also, the output horsepower falls off rapidly beyond the peak efficiency point because the engine governor has reduced some of the input power and the converter efficiency falls off rapidly. In such special applications, it is not expected that operation will occur beyond the peak efficiency point, but to insure against over heating of the converter, a governor should be used.

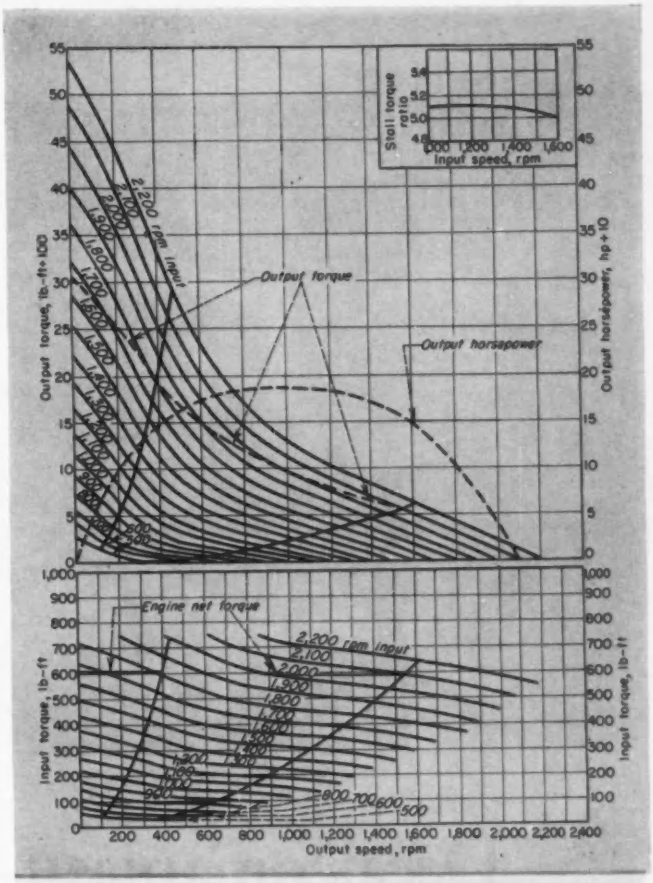


Fig. 6—Input-output torque curve for an M_s-390 series 1.0 converter. Each of lower curves represents a specific and constant input speed; each upper curve relates to specific torque available at given output speed.

Face up or slide off decalcomanias. These are films of paint or ink printed in several layers upon a removable paper backing. Intricate patterns, multiple colors, subtle half tones and embossed and fluorescent effects are attainable.

Decalcomanias for Product

DECALCOMANIA TRANSFERS are often considered to be the nearest thing to a panacea in the business of labeling. Noteworthy advantages over competitive identification forms include the following:

1. Manufactured of non-strategic materials. No metals, critical chemicals or similar shortage materials are required in their composition.

2. No holes or other fastening devices are necessary for application. Decals are so thin and adhesion so intimate that they seemingly become a part of the surface itself.

3. Lightweight durability. They may be considered a permanent application and usually wear as well as any finish they adhere to. Indefinite exposure of the trade mark or similar message is thus assured since it cannot be removed without injuring the surface of the article itself.

4. Speedy application; are easily applied by girl operators or unskilled labor.

5. Transparent backgrounds. When desired decals can be produced to give the appearance of unconnected, hand painted letters or designs.

6. Extreme versatility. Decals are available for application to almost any commercial surface either flat or curved, even coarse crinkle finishes and a wide variety of different materials including plastics, rubber, fabrics, wood, leather, ceramics and glass.

7. Economy. When purchased in sufficient quantity, cost is low.

Although there are many specialized forms of industrial decals—product identification labels, vitreous decals for the glass and chainaware industries, point of sale and truck advertising mediums, household and furniture decorations—all are printed on a special water soluble coating applied to a paper base. This backing serves as a vehicle for the printed film of pigments which is released by dipping the label in water prior to application. The designs can be built up on the paper by a variety of methods, but lithography is almost invariably employed, particularly when large quantities are involved. Silk screen stenciling is the most practical method when relatively small quantities of a given design are produced.

Decal designs are prepared on artist's drawing boards, usually double size in either black and white or colors, and are then photographically transferred to the particular requirements of the reproduction process that will be used. Most decal manufacturers are prepared to do this art work for their customers and usually submit preliminary sketches for approval before the

C. and H. Supply Co.

Metal-Cal designs are imprinted on 0.003 in. thick aluminum foil. The back of the Metal-Cal is coated with an adhesive which is protected by a cellophane film. Soaking in water removes the cellophane and activates the adhesive. Finger pressure is sufficient to insure a strong bond.

A typical decal application that combines manufacturer's name, trade name, catalog number, electrical rating and operating instructions. It actually consists of three individual labels.

Metropolitan Electric Mfg. Co.

Identification

EDWIN DREWITZ
Design Consultant

A versatile and inexpensive identification method with a timely plus factor thrown in—independence of probable defense materials. Decalcomanias have numerous other advantages over competitive methods.

master layout is finally developed.

Decal production processes are much slower and more complex than straight forward printing due to preparation procedures, long rack drying periods between different colors, and register requirements. Considerable use is still made of lithographic stones and flat bed presses. A separate stone is used for each individual color and some colors are printed two or more times to bring out the full depth of shade. Register, the correct relationship between impressions and colors, requires involved hand preparation.

To offset natural expansion and contraction of the paper vehicle during atmospheric changes, all papers are kept and processed in air conditioned press rooms. As a further precaution, each sheet is passivated, or accustomed to the press by being run through before any actual printing is done. Special inks are also ground, often by the decal manufacturers themselves, to meet this and other requirements. These involved procedures obviate the need for large unit runs to secure the lowest unit price. The complexity of the decalcomania design will, of course be an additional factor in determining the price. Generally decal prices break sharply when orders exceed five thousand units.

Types of Decalcomanias

The two most familiar types of transfers for commercial applications are the face up and face down varieties. Face ups or slide off decals, are the quickest and easiest to apply but their manufacture requires the trade mark or other design to be a closed, self-contained unit without detached figures or characters. The elements are joined by providing an opaque background in a contrasting color or a transparent film of lacquer. Production procedure is briefly as follows: The paper backing is coated with a suitable adhesive that seals the pores

Topflight Tape Co.

An application of pressure sensitive tape. Brass split bushings for oil well pumps are secured and labeled with strong, laminated cellophane tape.

and prevents the penetration of the oils in subsequent printings. On this, several opaque coatings are printed to provide a background and give body to the decal, followed by the various colors of the design itself. Finally a protective film or films of clear lacquer are coated over the printed matter.

Immersion of the decal in water releases the paper backing and allows the sandwich of pigments to be slid off and applied to the article to be decorated. The moistened adhesive provides a permanent bond. Unlacquered areas can be provided if changeable information such as serial and circuit numbers are to be added by ink pad stamping after application. The entire label may then be sprayed with a coat of clear lacquer to prevent the stamped information from rubbing off.

For large work, such as labeling farm equipment, capital machinery, freight cars, trucks and aircraft, and for general outdoor applications, slide off decals are often difficult to handle and position with any degree of accuracy. Consequently the older type face down or varnish decal is used. On this, the design is printed on the paper backing in reverse, top color first, and a varnish or other adhesive is used. Upon adherence, the paper is wetted and slid off, leaving the label in place.

The sometimes objectionable, clear lacquer film that serves to connect individual figures and other elements of a face up design is absent from the reverse decal, resulting in a hand painted appearance. It is effective on grained radio and TV cabinets, sewing and business machines, sporting goods, kitchen appliances and other consumer goods that require unobtrusive markings. Surplus varnish is removed with a benzene dampened cloth.

Reverse decals with a built in adhesive are also available when slide off application is practical. Double or duplex backing papers are oftentimes used on large open letter reverse decals. They are applied in the same manner as the aforementioned but consist of a thin tissue together with a heavier supporting sheet. The latter is separated at the moment of application. This leaves only the thin tissue in contact with the printed matter and permits the operator to see that every part of the transfer makes even contact.

Embossed and fluorescent decals are more recent developments. The former have a novel relief quality that resembles the surface of oil paintings. These raised effects can also be created on glassware, ceramics, and porcelain articles by vitreous decals which are permanently fused to the surface when the final glaze is fired.

Cost and Design Considerations

The initial cost of decals usually depends on three main factors: the number of colors required, the over-all dimensions of the intended design, and the desired quantity. The number of colors is a serious cost influence that should be considered at the outset. According to Mr. Alphonse Bihr, president of Palm-Fechteler and Co., decals may be divided into three main categories: (a) Having three or more colors, plus white, (b) four to seven colors, and (c) eight or more colors. He declares that labels in the latter two groups are likely to cost 33 and 66 percent more respectively than those in the first group.

To assist their customers in obtaining the lowest possible unit price by ordering larger quantities to cover extended periods of time and yet avoid the danger of deterioration due to improper storage facilities in their plants, many decal manufacturers agree to store the labels in their own air conditioned premises and ship them out as required. Some manufacturers increase unit quantities by adopting one standard decal nameplate with provision for a separate imprint of different dealers' names and addresses.

Proper design can further capitalize on the advantages of decalcomanias. Providing a shallow nest or depression for the decal will increase its life expectancy many fold and also pro-

vide a convenient painting guide for future reconditioning, if this is anticipated. Data, such as mechanical and electrical ratings which may vary from machine to machine, may also be inserted as a separate transfer in combination with the regular trade mark, if subsequent rubber stamping should be undesirable. An extra coating of clear lacquer, after the label is in place, will further increase its resistance to severe service hazards.

Other Decal-Like Forms

Two other label variations finding considerable application for product identification are comparatively new, the Metal-Cals and the pressure sensitive family of printed tapes and individual die cut forms. They are technically not decalcomanias although similar in mode of application and appearance.

METAL-CALS. The Metal-Cals may be described as an interesting cross between decals and the familiar metal nameplate. Although designs and copy are imprinted on a thin (0.003 in.) aluminum foil body, Metal-Cals differ from conventional name plates in that they are secured by adhesives without the aid of auxiliary fastening devices. Like decals they carry a built-in adhesive that is moistened in a pan of water. Soaking also serves to loosen a protective film of cellophane that is peeled off just prior to application. Under light finger pressure these labels attain maximum adhesion almost immediately and thus do not require prolonged drying time or special handling. Further, because of their thinness, individual information, such as serial and catalog numbers, may be filled in with a typewriter instead of special marking dies or stamps. Unlike decalcomanias, Metal-Cals obviously require the use of strategic material although to a considerably lesser degree than the heavier metal nameplates.

Metal-Cals have recently undergone exhaustive service tests at the Boeing Airplane Company laboratories and the results are particularly pertinent because the test aims and procedures closely parallel those required by the U. S. Armed Forces Procurement Branches, as follows:

1. Weathering. Labels were subjected to 3 min. rain and 20 min. sun cycles for ten full days in a weatherometer without adverse effects.

2. Abrasion. Metal-Cal markings were still clearly legible after 17,000 cycles with a Tabor-Abraser using a CS-10 wheel and a 1000 gram load.

3. Humidity, salt spray and low and high temperature. Test results indicated that Metal-Cals remained firmly bonded to their test surface at temperatures ranging from minus 62 F to 300 F. Humidity and salt spray tests resulted in no apparent loss in adhesion.

Metal-Cals are available in five different colors on bright aluminum or non-reflective matte finishes and will adhere to any smooth wood, metal, plastic, painted or glass surface.

PRESSURE SENSITIVE LABELS. Pressure sensitive identification devices feature a built in, self sticking adhesive similar to the familiar "Scotch" brand tapes and require only a light finger touch to produce a firm bond to any dry surface.

Printed tape nameplates, instruction and warning labels, and coding devices, are thin laminated cellophane structures consisting of an opaque, self adhesive base that carries the imprinted message together with a protective cover layer of clear cellophane. Tapes carry a chain of printed labels on convenient dispenser size rolls up to three inches in width. Official Air Force-Navy Aeronautical Standards, *AND*-10375 as well as other recognized warning and instruction symbols are available as standard printed tapes. Custom imprints may be had in single and multiple colors on many tape colors.

Individual printed and die cut stickers closely resemble the older water soluble adhesive types but because of their easier application and removal are finding ever expanding application possibilities. An original identification device that must be credited to this new form is the customer removable three way, identification, instruction, and protection plaque used on glass and plastic ware, household appliances (the ironing face of electric irons, for example) and cooking utensils.

These remarkable identification forms are logical successors to the original paper sticker types that must be moistened prior to application and then sometimes curl up or even fall off. They possess superior aging qualities and greater resistance to moisture, temperature changes, and abrasion. Removal, when desired, is also much easier and cleaner; no soaking or scraping is required, nor do they leave adhesive traces or in any way harm the finest of finishes.

AUTHOR'S ACKNOWLEDGEMENT

Grateful acknowledgement is hereby extended to the following organizations for their cooperation in the preparation of this report:
***C* and *H* Supply Company, Metal-Cal Division, Seattle, Wash.; De Jur-Amsco Corporation, Long Island City, N. Y.; Metropolitan Electric Mfg. Co., Long Island City, N. Y.; Topflight Tape Company, York, Pa.**

Special thanks are due Palm-Fechteler and Company, New York, N. Y. for detailed suggestions and data.

Palm, Fechteler & Co.

An example of the complex detail without sacrifice of legibility that is possible in decalcomania design. This slide-off label is printed in five colors plus white.

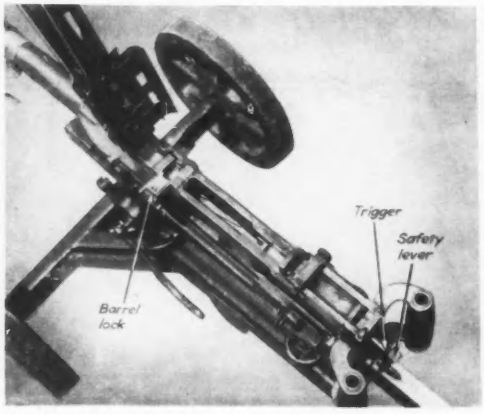
DESIGN FEATURES

Russian Small Arms

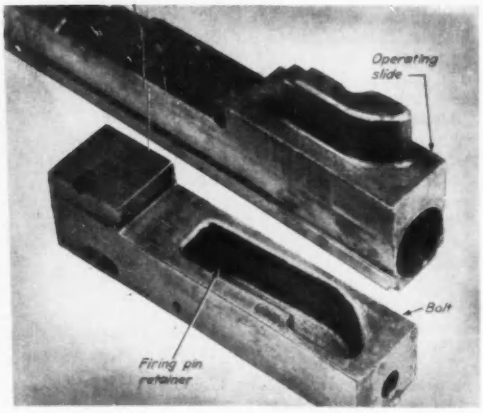
Although most of these Soviet-made guns do not meet American standards of production, their construction indicates that the Russians have not been slow to accept the best in arms design and adapt it to fit their facilities and needs. The Soviet policy of giving attention only to essential items is reflected in nearly every weapon. The guns shown on these pages were captured in Korea and sent to the Aberdeen Proving Grounds for analysis and evaluation. Pictures and data were obtained through the courtesy of the U.S. Army.

1. Goryunov Heavy Machine Gun Model 1943

Probably the simplest belt-fed heavy machine gun ever made, the Goryunov is also one of the best. It is a gas-operated, air-cooled piece that uses 7.62 mm standard rifle and machine gun ammunition in a non-disintegrating metallic or fabric belt. The gun weighs 30.4 lbs alone, 89 lbs with the mount. It has a firing rate of 550-700 rounds per minute. If the gun is removed from the mount and the trail of the mount raised, the Goryunov machine gun can be mounted on a swivel at the end of the trail for anti-aircraft use. Field stripping of the piece is fast and simple; no tools are required. The few component parts are rugged and designed for easy machining. Recoil spring drives the recoiling parts forward after they have been forced backward by gas pressure and also actuates the firing pin.

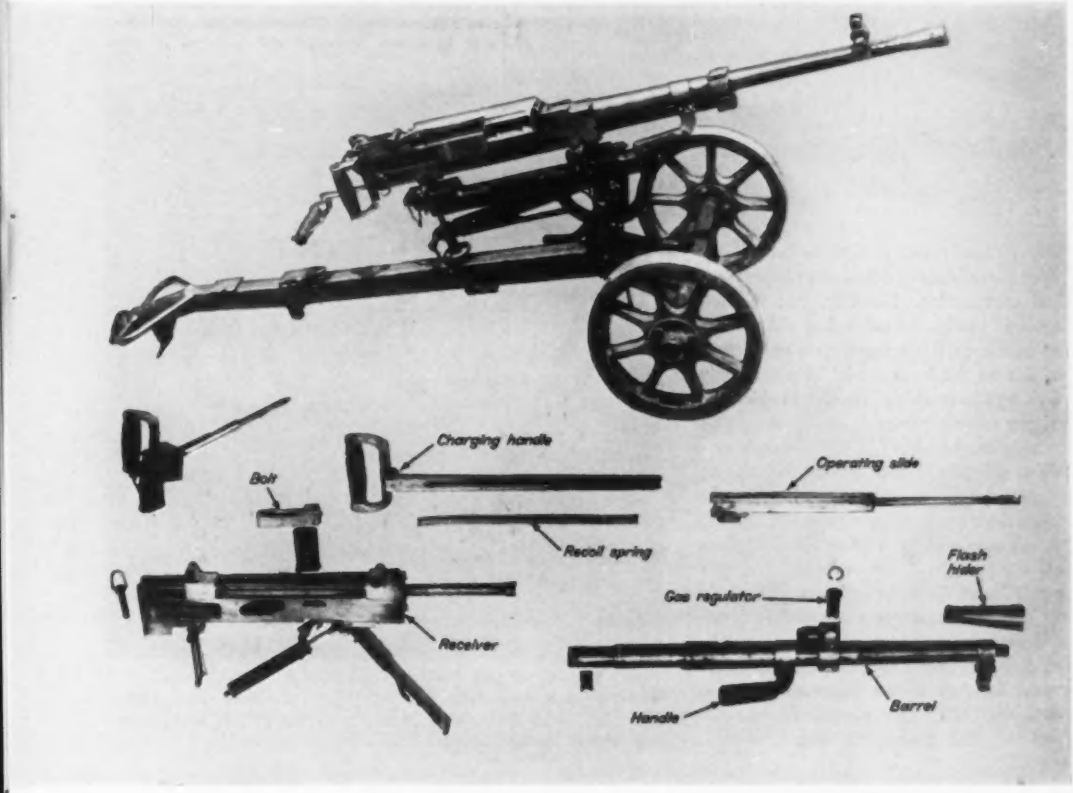


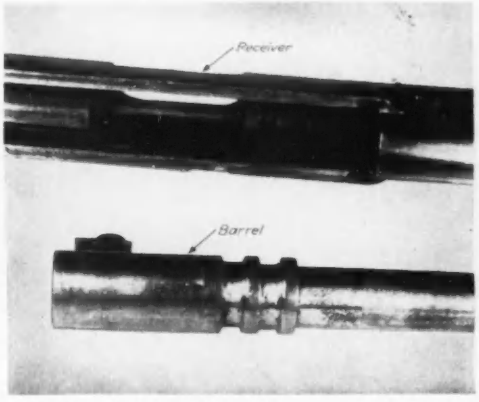
SIMPLE BUT EFFECTIVE SAFETY is a spring-loaded lever that must be depressed to actuate the trigger and must be held depressed during firing. Barrel lock is a simple, sliding plate that engages shoulders on barrel.



MOTION OF THE BOLT is controlled by the operating slide by means of a lug that fits into a slot in the bolt. For locking, the right rear shoulder of bolt engages shoulder in receiver. Firing pin retainer passes behind the pin.

IN NEW PRODUCTS





BARREL, which has thick walls to retard over heating, can be removed in a few seconds. This is accomplished by pulling the barrel forward away from the receiver after disengaging the barrel lock by sliding it to the left.

TANGENTIAL SLOTS on the gas regulator permits gases from barrel to reach piston on forward end of operating slide. Slots are easier to machine and do not foul as readily as radial holes used on most guns. (*continued on next page*)

Muzzle brake, front sight, bayonette stud and gas nozzle are combined into one assembly which screws over front end of barrel and is keyed in place.

2. Tokarev Semi-Automatic Rifle—Model 1940

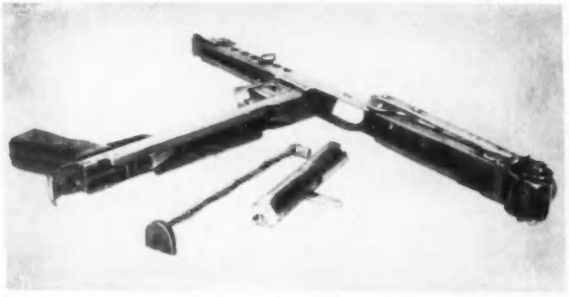
Gas operated Tokarev is made in two versions that are nearly identical in appearance and construction. However, one is semi-automatic only; the other fires either semi-automatic or full-automatic. Selective type of fire on the latter model involves only flicking a lever which is mounted behind the trigger and also serves as a safety lock. This version can be identified by the notches on either side of the stock behind the trigger; other version has only one notch on the stock since the function of the lever in this case is merely one of a safety. Both versions are equipped with muzzle brakes to reduce recoil forces. Curved magazines which hold 10 7.62 mm cartridges accommodate standard rimmed-case ammunition and can be loaded with two five-round charges either when attached to the weapons or when detached. The gun weighs 8.6 pounds and is 48.2 inches in length overall.

TRIGGER, shown locked by the safety lever, actuates the sear to release hammer that strikes the firing pin. Auxiliary sear prohibits firing until bolt is fully closed. In fully automatic models, this auxiliary sear releases hammer to make continuous firing possible.

All major parts except the barrel, firing pin and bolt are inexpensive stampings.

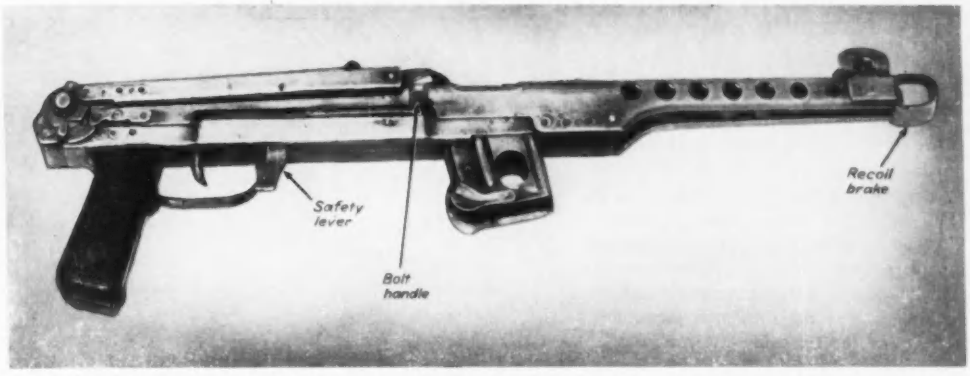
3. Sudaev Submachine Gun—Model 1943

Designed for inexpensive production on a large-scale basis, the Sudaev is outstanding in its class for performance. Blowback operated, it fires 7.62 mm cartridges at a cyclic rate of 600 rounds per minute. With a loaded 35 round magazine made of stamped sheet steel, the gun weighs 8¼ pounds.



HEAVY BOLT is made by welding handle on a piece of machined bar stock. Fixed firing pin is pressed into one end. Spring, with fibre buffer attached, is used to absorb the rearward thrust of the bolt. Gun is easier to field strip than M3A1, the U. S. counterpart.

GAS-MECHANISM is located above the barrel to keep the bore axis close to the center of the butt stock and thus minimize upward whip during firing. Piston is rigidly attached to the barrel; the cylinder moves. Machining on all pieces is kept simple and to a minimum. Bolt carrier cams rear end of bolt upward for unlocking, but bolt cannot be held open when gun is loaded. Two-piece recoil spring has a telescoping type guide to permit assembly.

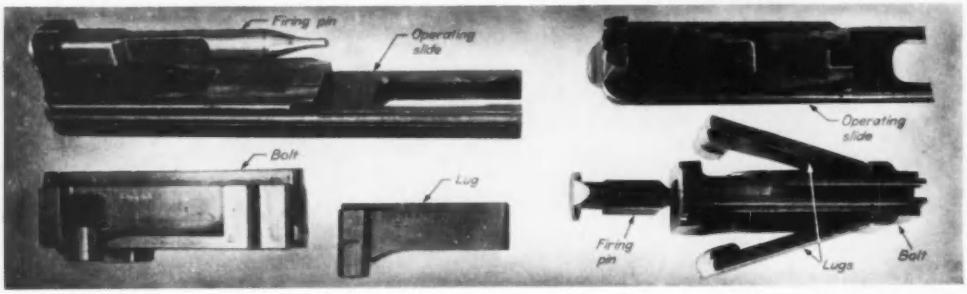


NOVEL PIVOT for butt plate locks in one direction and requires no special catch to hold it in place. A simple hinge folds the stock over the barrel. Few, if any tolerances, on the gun are critical. Magazine is not always interchangeable, reflecting the non-precision nature of Soviet armament manufacture. Overall length of the piece is 32¾ in. with the stock extended, 24½ in. with the stock folded as shown above. (*continued on next page*)

4. Degtyarev Light Machine Gun—Model 1928

The weight of this 7.62 mm machine gun with its unusual bipod mount is only 18½ pounds. Fired fully automatically only, in the prone position, this gun has a cyclic rate of fire of 550 rounds per minute. Practical rate of fire, which includes reloading time, is 80 rounds per minute. Fitted with a wooden stock and flash hider, the piece is 50½ in. overall. Except for the magazine which is not generally interchangeable between guns and must be checked by actual firing, the DP is an excellent machine gun.

MAGAZINE consists of a lower stationary pan and an upper, revolving pan. Upper pan, which is actuated by a flat spiral spring has individual spaces to fit 47 rimmed type cartridges.

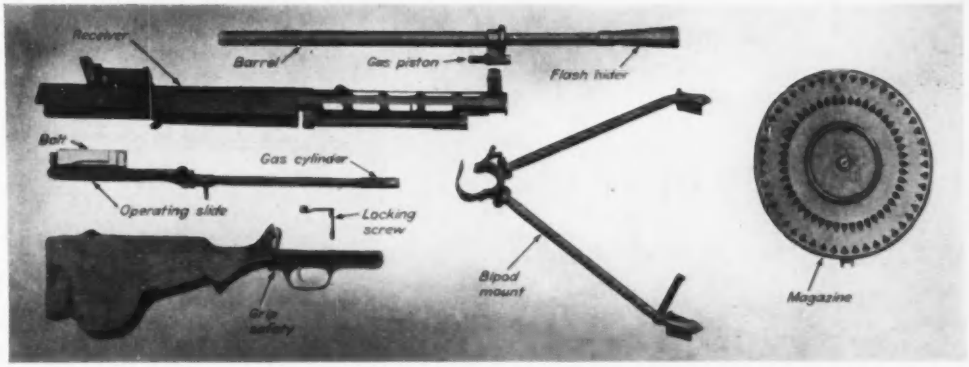


BOLT REQUIRES complicated machining but all parts are rugged. Firing pin can be removed easily, without tools. Firing cycle begins with bolt, firing pin and operating slide in their rearward position. Bolt is locked by symmetrical, spreading lugs until operating slide, released by trigger, cams lugs inward. Lugs provide large locking area, permitting relatively soft steel to be used in the receiver. During recoil, firing pin and slide move rearward.

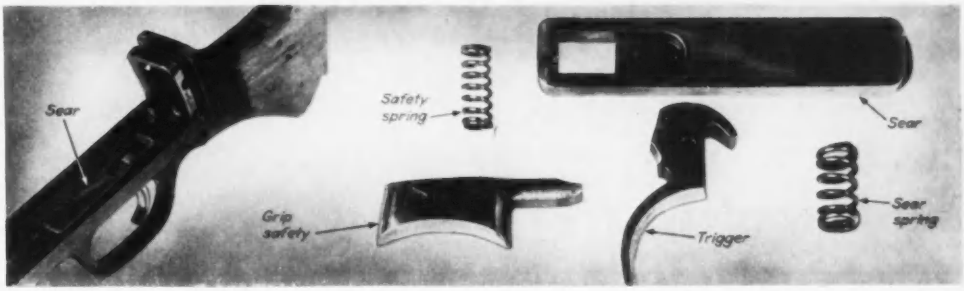
5. Tokarev Pistol—Model DP

This small but effective pistol is patterned after the 45 Colt, but is considerably simplified. The grip and manual safeties of the American Colt have been eliminated and half-cock of the hammer is the only safety lock on the piece. Eight rounds of 7.62 mm standard Soviet pistol and submachine gun ammunition can be loaded into the detachable magazine which slips inside the handle. The catch for removing the magazine is conveniently located behind the trigger. The external, ring-spur type hammer is easy to operate and will not catch on clothing.

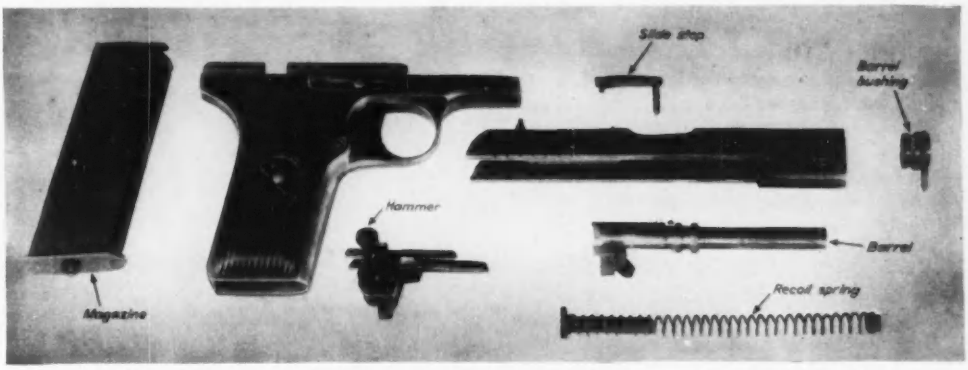
LOCK MECHANISM consisting of hammer, sear and disconnector is enclosed in a single housing for easy maintenance. Plastic grips are fastened by internal levers instead of screws. Basic action is identical



BARREL IS RETAINED by interrupted threads which require only a $\frac{1}{4}$ revolution for disengaging. Fixed gas piston is removable with the barrel. During firing, the cylinder moves completely out of contact with the piston to exhaust the gases. Loading is a slow process. Each round must be inserted individually into a hole in the magazine.

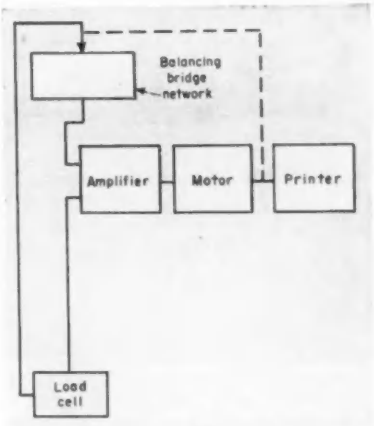


TRIGGER GROUP is simple, strong and effective. Operating slide is held in cocked position by spring loaded sear. Pulling trigger forces sear down, releasing the operating slide. Safety button, which engages the rear surface of the trigger, automatically prevents firing when not depressed. Wooden stock is held by only two screws, which does not provide rigidity for rough handling. A butt plate was not considered necessary by Soviet designers.



to that of the Colt. Ribs on the barrel fit in grooves in the receiver to lock the barrel and slide together during the first part of the recoil stroke. When the gas pressure has decreased, the pivot at the end of the barrel lowers the barrel, disengaging it from the slide, and the slide completes the recoil stroke alone.

WEIGHING PLATFORM for this scale is made from structural steel beams with adaptors for the load cells bolted to each of the four corners. Each cell consists of a calibrated, load-receiving column to which is bonded an SR-4 electric resistance type strain gage.

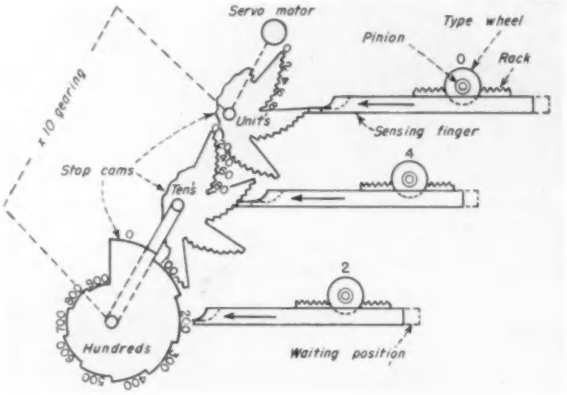


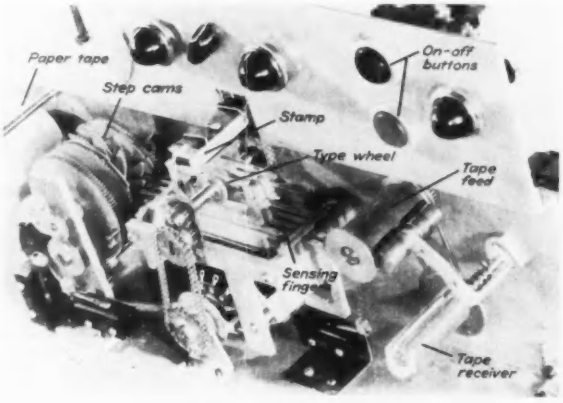
OUTPUT VOLTAGE from strain gage drives servo motor through elements shown above. Motor rotates a precision potentiometer until the system has been balanced.

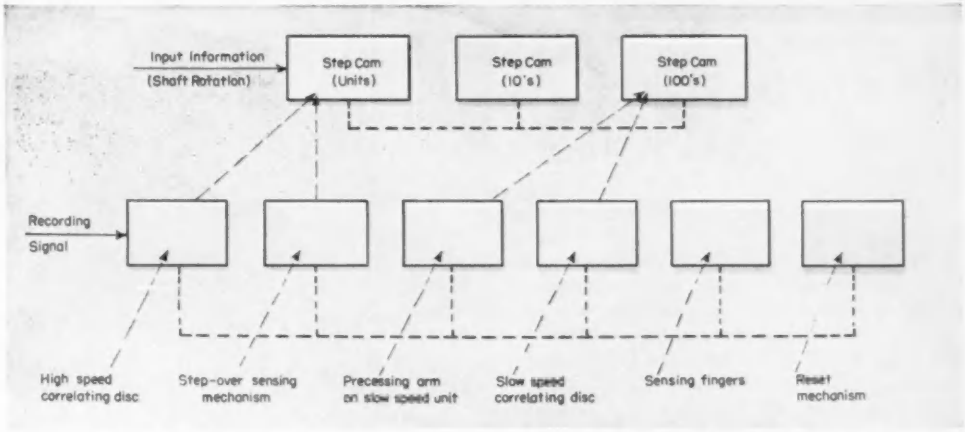
Electronic Scale and Recorder Uses Standard Components

Using standard Baldwin load cells connected to an electrical balancing unit by means of a servo system The Streeter-Amet Company of Chicago has developed an economical, compact and accurate electronic scale. A recording attachment, also made of standard components, permits weight data to be received and printed at a convenient point which can be removed from the scale itself. Although originally intended for large capacity systems, this installation can also be adapted for a small capacity. The recorder and servo systems are essentially independent of capacity and interchangeable load cells of different sizes are commercially available.

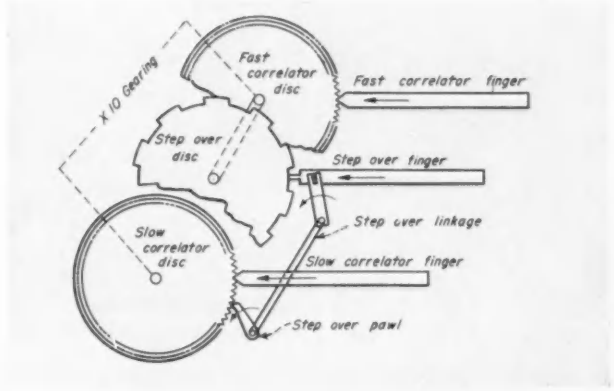
Its compactness and ease of installation, operation and maintenance make this electronic scale useful for dynamic as well as dormant industrial weighing operations.



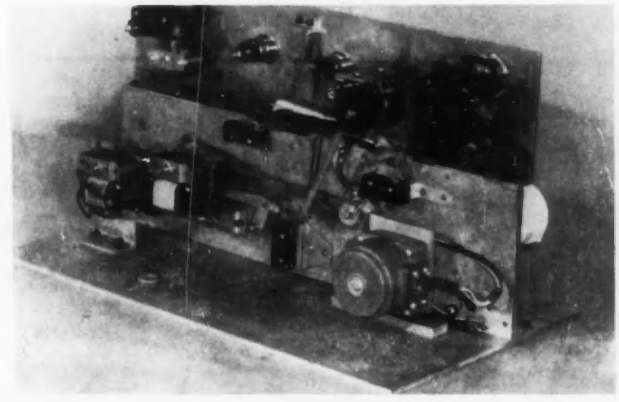




BALANCING SERVO MOTOR also operates the recording apparatus which consists of a series of step cams to convert rotational data from the motor shaft to digital information on the printer. Cams are rotated through an angle which is directly proportional to the weight on the scale. Balancing circuit is phase sensitive and removal of force from load cell reverses direction of rotation of motor. Temperature compensating resistors are included in each load cell.



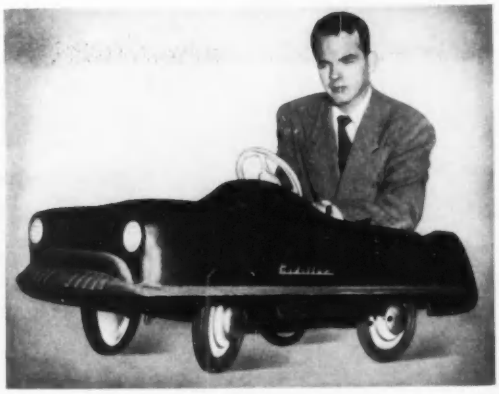
CLOSING SWITCH in printer circuit causes printer motor to move sensing fingers into contact with the step cams. Fingers, which position type wheels, are directed into the correct step of cams in a definite sequence by correlating and step over disks (right). When step cams are positioned, one sensing finger moves into the high speed correlating disk which checks position of the high speed step cam. If cam is slightly out of position, sensing finger meshing with correlating disk will correct it. Step over sensing disk operates from same shaft as the high speed correlator and is positioned at the same time. This step over disk positions the low speed correlator which in turn positions the low speed step cams.



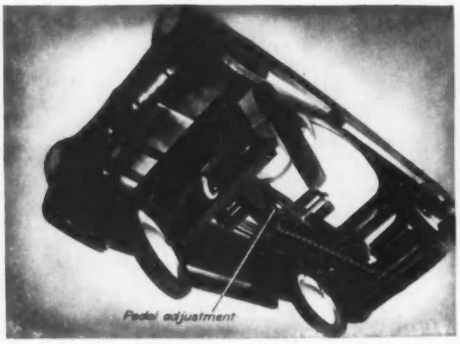
TOP FRONT VIEW of recording unit (left) with housing removed shows how type wheels are driven by the sensing fingers. When wheels are in proper position a cam actuates the stamp to print the data. When print has been taken, sensing fingers are brought back to waiting positions by lever action. (Right) Rear of the recording unit with the housing removed. A hand-operated potentiometer in series with the balancing potentiometer provides adjustment in the event a recorder reads other than zero when there is no load on the scale. Changing from one load range to another is accomplished by adding a resistance in series with the hand-operated potentiometer to balance the system and bring recorder to zero with load on the scale.

1951 Kidillac Features New Drive and Styling

Styling and design of this toy car reflect current trends in the automotive industry. Its one piece body, high-line fenders, cadillac-like tail, and low silhouette are appealing to young drivers; its sturdy construction, low center of gravity and enclosed chain drive are appreciated by their parents. Designed by the Harley Earl Corp. of Detroit, the Kidillac has a 22 in. wheelbase, 14 in. tread and 46 in. overall length. Tires are 2 in. by 6 in. semi-pneumatic, cockpit is 12 x 16 inches. To add variety, there are paint and trim variations. Chrome head and tail-light bezels are used in some models. Cockpit contours are painted in a second color to give effect of convertible with the top down.



ENTIRE BODY SHELL is stamped out of one piece of metal, whereas models it superseded were made of 14 different stampings. The low silhouette is for appearance, the low center of gravity for safety. Semi-pneumatic tires of sealed tubular cross section are for a softer ride.

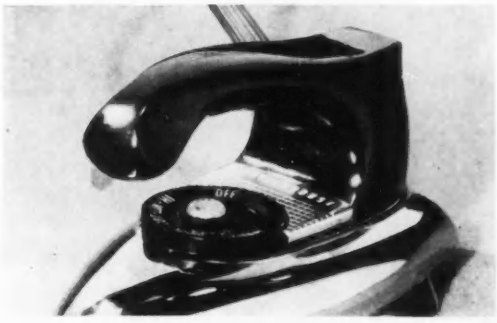


ENCLOSED DRIVE MECHANISM, with a two-to-one ratio, is bolted to a mounting that is welded to the seat. This simplifies assembly and eliminates bolts through the seat. Rear axle has three ball bearings, one at each wheel and one in the center. Adjustable pedal distance accommodates 4-6 year o'd groups.

ONE-PIECE SEAT, the only other stamping, is spotwelded to the underside of the body. Contoured shape of the seat reduces sliding when alternating force is applied to the pedals. All flanges on the seat and the body are rolled under for safety. Windshield, which is drawn from the body shell, serves as instrument panel and bearing surface for steering shaft.

Open Handle Eases Ironing Burden

Newly styled handle eliminates the physical strain in ironing by permitting the wrist and hand to remain in relaxed position during all ironing operations. A slight pressure of the forefinger or thumb moves it to the left or right. The open front design, developed by the Westinghouse Electric Corporation, enables the iron to slip into pockets, pleats, sleeves and seams.



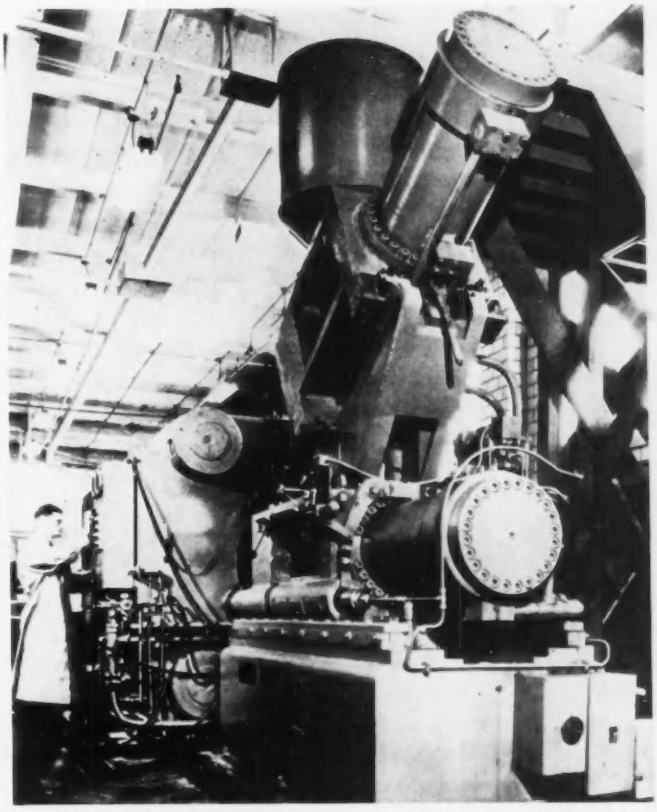
Preplasticizer Triples Capacity of Molding Press

By adding a preplasticizing cylinder to an 85 ounce horizontal injection molding machine, the capacity has been increased to 300 ounces. The function of the preplasticizer is to take plastic material from the hopper in relatively small amounts, heat it uniformly, and pack it into the main injection chamber where it is stored, at proper molding temperature, until there is a sufficient quantity to make a shot.

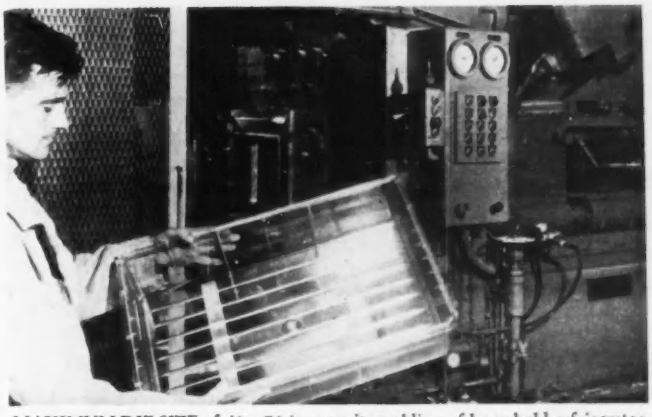
To accommodate different size dies, the injection ram pressure is adjustable up to 2,850 psi, and die clamping pressures up to 3,000 psi can be maintained. Since the main clamping ram is the single acting type, twin auxiliary cylinders are provided for the fast advance and return speeds of the clamping ram, with slowdown periods provided during the actual die opening and closing. Travel of the plasticizing, injection and clamping rams is controlled by the main oil pump, while a smaller pump maintains pressure on the clamping ram during the entire holding period.

An accurate and sensitive control of clamping ram travel for die setting is obtained by means of the inching control hand wheel located on the front of the machine, which provides a stepless variation of hydraulic power from zero to maximum. A 12-in. spacer is provided between the clamp ram and movable die plate which can be readily removed to accommodate deeper dies.

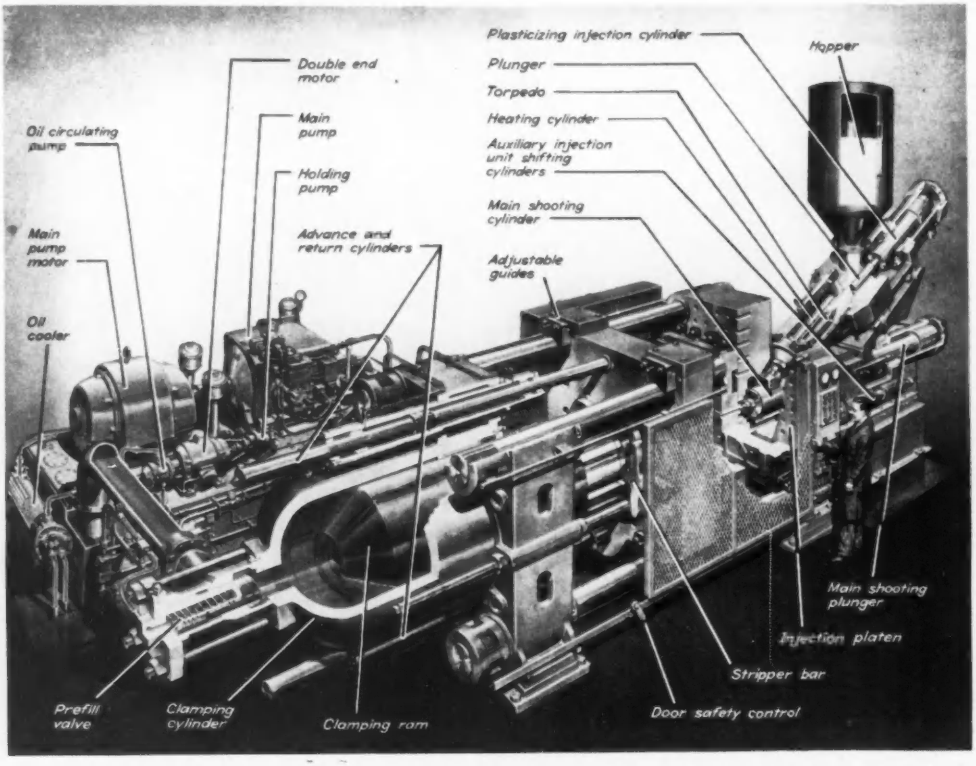
Manufacturer is the Watson-Stillman Company of Roselle, N. J.



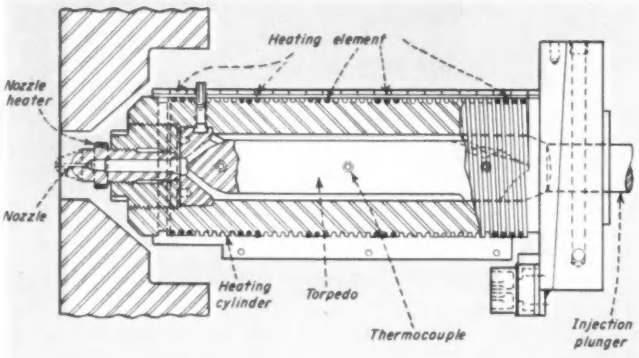
TO ACCOMMODATE the needs of a specific job, operator can select either manual or single cycle automatic operation, adjust the speed of the injection ram, the injection and clamping pressures and the temperature of each of the heating elements in the preplasticizing and injection cylinders.



MAXIMUM DIE SIZE of 48 x 72 in. permits molding of household refrigerator panels and trays like the one shown above. Max daylight opening of dies is 72 in. without a spacer, 60 in. with a spacer. Stripping capacity is 98 tons.

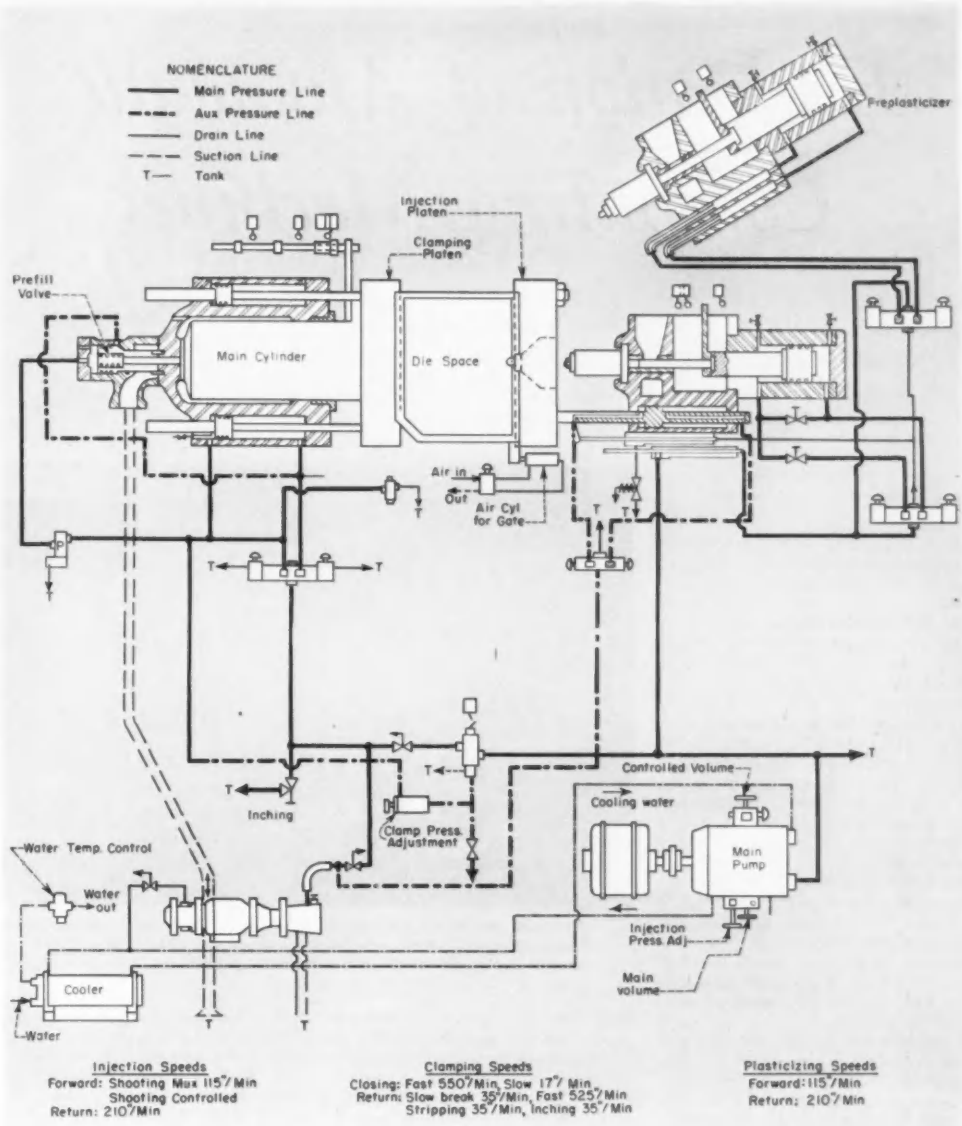


CYCLE STARTS when the safety door is closed permitting the clamping unit to move forward with a rapid advance and a slowdown prior to die contact. When proper clamping pressure is reached, the main shooting plunger injects the plasticized material into the die cavity. The quantity of plastic supplied to the main shooting cylinder is pre-determined by a setting on an adjustable control rod. When the shooting cylinder is filled, the plasticizing plunger returns to its rear position allowing additional plastic to flow into the heating chamber. A shut-off device between the plasticizing cylinder and the shooting cylinder closes preventing material from being forced back into the plasticizer during the injection stroke. This entire recharging of the shooting cylinder is done during the curing part of the cycle. The clamping unit returns, stripping the finished piece, to complete the operating cycle of the machine. The stroke of the clamping platen is adjustable to suit the requirements of the mold and molded part, thus making it possible to operate the machine at required stroke



HEATING CYLINDERS in the preplasticizing and injection units are interchangeable although the number of heating elements in either can be varied to fit a specific need. A typical heating cylinder contains calrod heating elements on the cylinder plus a cartridge type heating unit in the torpedo. All elements are zone controlled by the operator to fit specific material and die requirements. All internal surfaces in contact with the plastic material are highly finished and chrome plated. Feed control from the hopper is readily adjustable.

A maximum of 300 ounces or approximately 390 cubic inches of material can be injected per shot.



MAIN PUMP SUPPLIES OIL to two quick advance and return cylinders to drive the clamping platen forward. A port in the lower cylinder actuates a valve at the front of the clamping cylinder to keep pressurized oil from the cylinder but non-pressurized oil is drawn in from the tank by vacuum. When the dies are nearly closed, the output of the main pump is diverted to the plasticizing and injection cylinders; the holding pump completes the closing and maintains positive clamping pressure (3,000 psi). Clamping pressure is applied to the main clamping cylinder as well as the smaller cylinders since the port output is cut off. This gives the desired slow speed during clamping. Molds also part at slow speed, slowdown speeds of both strokes being adjustable to different dies. Stroke of the clamping platen is also adjustable to reduce waste motion. Timing of the system is controlled by microswitches, as shown, plus three electrical timers. One starts the plasticizing ram forward, another controls the curing time, and the third controls the slow return of the clamping platen. Pushbuttons start and stop the motors. Injection stroke is controlled by hand switches which operate main operating valve.

Evaluation of Automatic Computing Machines

Time saving is one benefit of automatic computers. Another is that these machines make practical mathematical investigations that could not be considered before. The principal types of computers are described and compared.

FRANZ ALT
National Bureau of Standards

HUGE COMPUTER, known as "UNIVAC", is in use at the Bureau of Census, Philadelphia. In the rear of the picture is the cabinet wherein the computations are performed. Balance of the equipment in the room are for control, for memory,

IT IS STILL TOO SOON TO FORECAST accurately what effects the new high speed computing machines will have on design calculations. But it is almost certain that computers eventually will become an engineering tool in any field where mathematical calculations are complex or extensive. This becomes evident with even a generalized knowledge of computers, what they can do and the changes in mathematical philosophy that have already taken place.

Until very recently mathematicians would consider a problem solved if a formula could be found representing the solution. In the absence of such a formula, an acceptable alternative was a set of rules for a procedure that if iterated often enough (possibly infinitely many times), would lead to an answer. In the past decade, however, it has become increasingly customary to look for definite numerical solutions to problems.

A numerical solution does not give as much information about the general nature of the problem, but it gives a great deal more specific information about the case at hand—information which cannot be obtained from a formula or iterative process without a great deal of additional work. And, even more important, numerical answers can be obtained for a large number of problems for which a solution in the older sense is either impossible or at least not known.

This changed attitude of mathematicians has been brought about because there are now available practical means for obtaining numerical results quickly and cheaply. Where before it was necessary to have human computers work for days or months on a single problem, there are now machines which turn out the same answers in a few minutes. The machines can be used to obtain in a reasonable amount of time the solution of problems so long or complicated that they were formerly beyond reach.

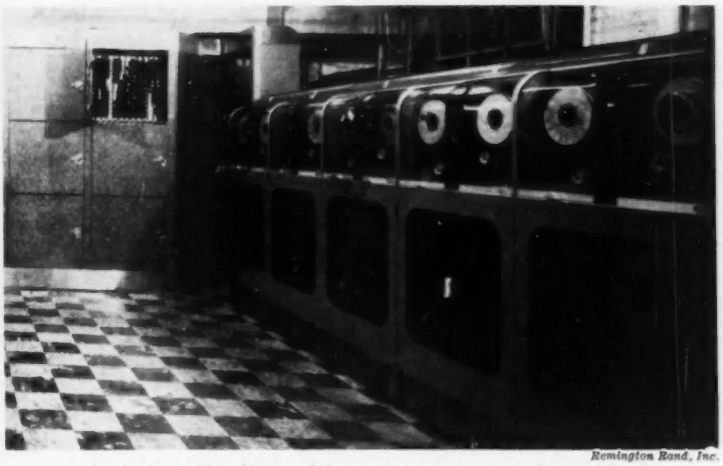
Type of Computers

Computing devices are divided into two broad classes according to the way in which they represent numbers. Devices of the first class are called analogue or continuous variable devices. They represent numbers by measuring some physical quantity, such as a voltage or resistance, angular displacement of a rotating shaft or disk or the position of a hand on a dial. Devices of the second kind are called digital or discrete variable devices. They represent numbers by counting concrete objects in space or discrete events in time, like teeth of a gear wheel, holes in a paper card or tape, or electric pulses occurring in a circuit. To the former class belong such simple devices as the slide rule and the various planimeters, and such complicated machines as differential analyzers, network analyzers, linear equation solvers and fire control computers associated with most antiaircraft guns. Examples of digital machines are the ordinary adding machines, desk

Parlor Game for Engineers

Many digital calculating machines do things the hard way. Multiplication, for example often is performed as addition simply because of the nature of the machines. Obtaining a product by addition is tedious and time consuming when compared to direct multiplication. However, the tremendous speed of the machines makes such drawbacks insignificant. A pencil and paper explanation of the "machine method for multiplication" makes an intriguing demonstration.

1. Take any two numbers	26 × 41
2. Double the number on the left and halve that on the right — successively, until the right-hand number reaches unity. Disregard any fractions	52 × 20 104 × 10 208 × 5 416 × 2 832 × 1
3. Cross-out all lines with even numbers in the right hand column, which leaves	26 × 41 208 × 5 832 × 1
4. Add numbers remaining in the left-hand column	1066, which is the product of 26 and 41.



Remington Rand, Inc.

for the input of problems and for receiving the solutions. To the left of the main cabinet is the unit that types data and instructions on magnetic tape for input to the machine. This is typical of the modern computing machines.

calculators (Marchant, Friden, Monroe), punched card machines, and the modern large automatic digital computers.

In general, analogue machines are easier both to construct and to operate. Even relatively complicated machines like the differential analyzers are built up from simple components which carry out the usual arithmetic operations. In a mechanical instrument, for instance, which represents functions by the rotation of shafts, ordinary gears can be used to effect the multiplication of a function by a constant, and differential gears, similar to those used in the rear wheel drives of automobiles, produce the sum or difference of two functions. Multiplication, division and other arithmetic operations can be incorporated if desired. And, most important of all, there are simple components which obtain the integral of a function. These "integrators" make it possible to perform automatically such tasks as the integration of systems of ordinary differential equations of relatively high order, the solution of some types of partial differential equations and the solution of integral equations. In addition to these mechanical components, there are electrical circuits which perform the same mathematical operations. The use of integrators is so easy that integration is often employed in place of operations that under other circumstances are much simpler. Thus, the square of a function y is worked out as $\int 2y\,dy$, the product yz as $\int y\,dz + \int z\,dy$. Also, transcendental functions like e^x or $\sin x$, are obtained by integrating their differential equations ($y' = y$ or $y'' = -y$).

Digital machines, today, employ three kinds of principles for the performance of mathematical operations: mechanical, electromechanical, and electronic. The most elementary mechanical component is the counter-wheel, a gear wheel with ten teeth, whose function is generally understood. This and other mechanical components are used in all adding machines and desk calculators. They are employed also in most of the standard punched card machines and to some extent even in large-scale automatic machines, like the "Mark I" at Harvard University.

Next in the order of chronological development are electromechanical elements, including electrical circuits that are completed through holes in paper cards or tape, relays and stepping switches. Earlier models of the current group of huge machines were in a large part made up of electromechanical devices. Electronic computing circuits have now come into prominence. These are incorporated in some of the more advanced punched card machines and in the modern large-scale automatic digital computers.

Mathematical Operations

The basic elements like a counter-wheel, a series of relays or a fairly simple vacuum tube circuit can be used to count and to add single-digit numbers. Banks of such elements make it possible to handle numbers consist-

ing of several digits. Multiplications can be carried out by repeated addition; division and sometimes square roots, by repeated subtraction, all in essentially the same manner as on desk-type calculating machines. But this is as far as existing or projected digital machines, almost without exceptions, will go. Anything more complicated than these basic arithmetic operations, for example the evaluation of transcendental functions or integration, must be programmed by the machine operator. He is obliged to replace the complicated operations by sequences of elementary operations and to set up the machine to perform operations in the required sequence.

Transcendental functions, including trigonometric, exponential, logarithmic, or any of the more sophisticated functions of higher mathematics, are usually dealt with in one of two ways. They can be expressed by an infinite series, such as a power series, of which as many terms are computed by the machine as are needed to give the desired number of significant figures. Or, a "table" of such a function is stored in the machine and referred to when needed. The latter method also covers empirical functions for which no analytic expression is available. The "table" may be quite small, and any value not contained in it can be obtained by interpolation. A third method for working out a transcendental function involves stepwise integration of some differential equation of which the function is a solution. This is used occasionally with digital machines and much more commonly with analogue machines. Still other methods apply in some special cases.

Integration is always performed by using one of the customary methods of numerical integration, such as Simpson's rule or any one of the more elaborate known methods. The mathematician who prepares the problem and operates the machine has to specify the sequence of multiplications and additions required by the selected method of numerical integration. This is the principal reason why the operation of digital machines is more cumbersome than that of analogue machines.

Accuracy

This drawback of digital machines is more than offset by a number of advantages. Foremost among these is their accuracy. Because digital machines must approximate infinitesimal operations, like integration, by methods of finite differences, while analogue machines can be made to perform such operations directly, it may be thought that analogue machines are inherently more accurate. In fact, the contrary is true. Since analogue machines rely on measuring physical magnitudes (lengths, angles, volts), their accuracy is limited by the precision with which these magnitudes can be measured. Even in the most carefully designed instruments, the measuring error is at least one part in 10,000, and in the more common electronic analogue devices it is as high as several percent. On the other hand, the accuracy of a ten-bank desk calculator, or of any digital machine of comparable capacity, is one part in 10^{10} for each operation performed. Even after millions of operations the accumulated rounding error is still very small. The error committed by replacing integration by a finite-difference process (the so-called "truncation error") can be made as small as desired by choosing a sufficiently small step for numerical integration. It is quite feasible to keep this error below one part in 10^{8} or even 10^{10} without prohibitively increasing the number of steps required.

Related to this accuracy characteristic is another advantage of digital machines. If the same problem is done repeatedly on a digital machine, the answer is always the same, unless the machine breaks down. If a problem is repeated on an analogue device, the answers will, in general, be slightly different from each other. The reproducibility of results is of great value in spotting machine failures in the operation of digital machines.

Speed

In the matter of speed, the analogue machines are slightly ahead at the moment. A linear equation solver performs its task in a matter of seconds. A differential analyzer will integrate the equations describing the flight of an artillery shell in anywhere from 10 min down to a fraction of a minute, depending on the accuracy desired. Greater speeds can be obtained at the expense of accuracy. Among digital machines, only the most modern electronic computers can match these speeds. However, the development in the digital field is not closed. Future machines capable of higher speeds are more likely to materialize in this than in the analogue field.

Still another characteristic of digital

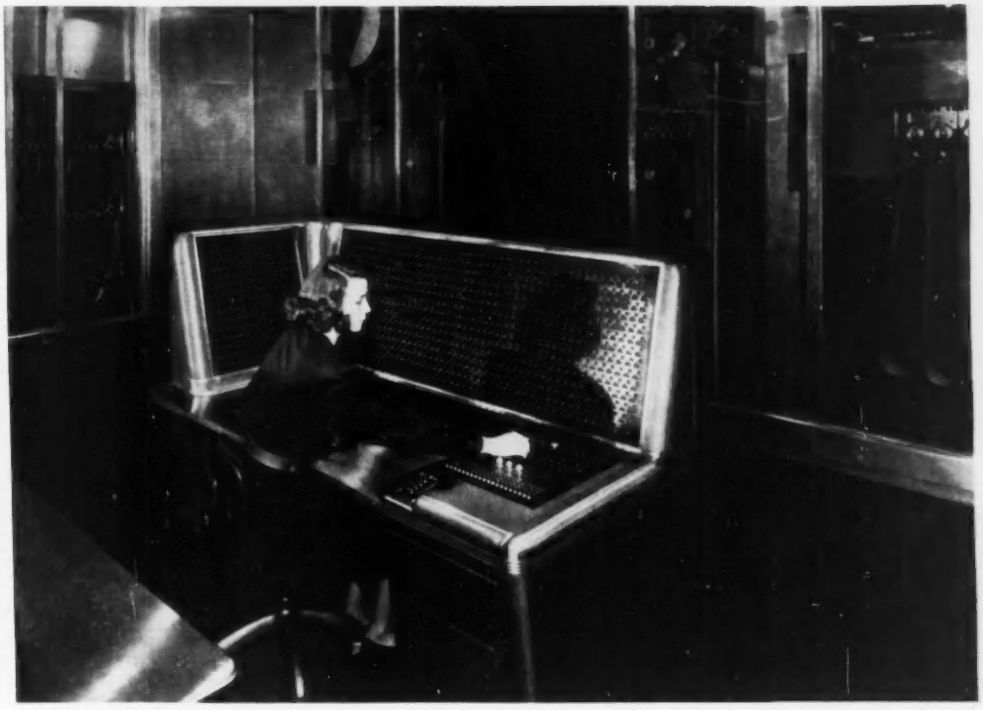
Summary of Automatic Digital Computer Development Projects in the United States

A. Machines in Operation

	Memory: Number of words and Storage Medium	Input & Output Medium	Multiplication Time, incl. av'ge access time	Number of Tubes	Number of Crystals	Location	Completed
ENIAC	20-Vac. Tubes	Punched Cards	2.6 millisec	18,000	0	Aberdeen Proving Gd.	1946
SSEC	8-Vac. Tubes 150-Relay 20,000-Perf. Tape	Punched Cards & Perf. Tape	20 millisec	12,000	0	New York	1948
SEAC	512 Mercury 512 Cath. Ray Tube	Perf. Tape Magn. Tape	2.7 millisec	1,200	19,000	Washington	1950

B. Machines under test (as of early part of 1951)

MARK III	4,350-Magn. Drum	Magn. Tape	12.9 millisec	5,000	1,200	Dahlgren Proving Gd.	——
UNIVAC	1,024 Mercury	Magn. Tape	3.0 millisec	4,000	25,000	Philadelphia	——
E. R. A.	16,000 Magn. Drum	Perf. Tape	1 to 68 millisec	3,000	0	Washington	——



CONTROL DESK for the IBM "Selective Sequence Electronic Calculator". At all stages of a computation, the indicator lights show what unit is in operation, the operation being performed and the results being achieved. The machine is in New York City.

machines, especially of the most modern ones, is a great capacity for accommodating large and complex problems. Also, a digital machine can be adapted to a wide variety of problems. An analogue machine is designed to handle only one type of problem, or at most a few related types. And, even within these types, the capacity of an analogue computer as to magnitude of problem is severely limited.

For instance, a linear equation solver can do nothing but problems which can be reduced to systems of linear equations. In addition, a given machine can handle systems of only limited order. Twelfth order systems are about the limit. A differential analyzer is somewhat more flexible, but is really efficient primarily when applied to ordinary differential equations. The order of equations which the machine can handle depends on the number of integrators. The mechanical analyzer that is installed at the Massachusetts Institute of Technology has 18 integrators. Some electronic analyzers have a few more. But when it is attempted to build an analogue machine of substantially greater capacity, serious engineering difficulties are encountered. On the other hand, a modern digital machine is adequate to such diversified problems as evaluation of complicated explicit expressions, solution of algebraic (or transcendental) equations, of ordinary as well as partial differential equations, integral equations and numerous others. Also, the size of the problems which can be handled is much larger than for analogue machines—for instance, systems of several hundred linear equations, or ordinary differential equations of very high order. The limit is usually set not by the capacity of the machine but by the mathematical difficulties posed by such large systems.

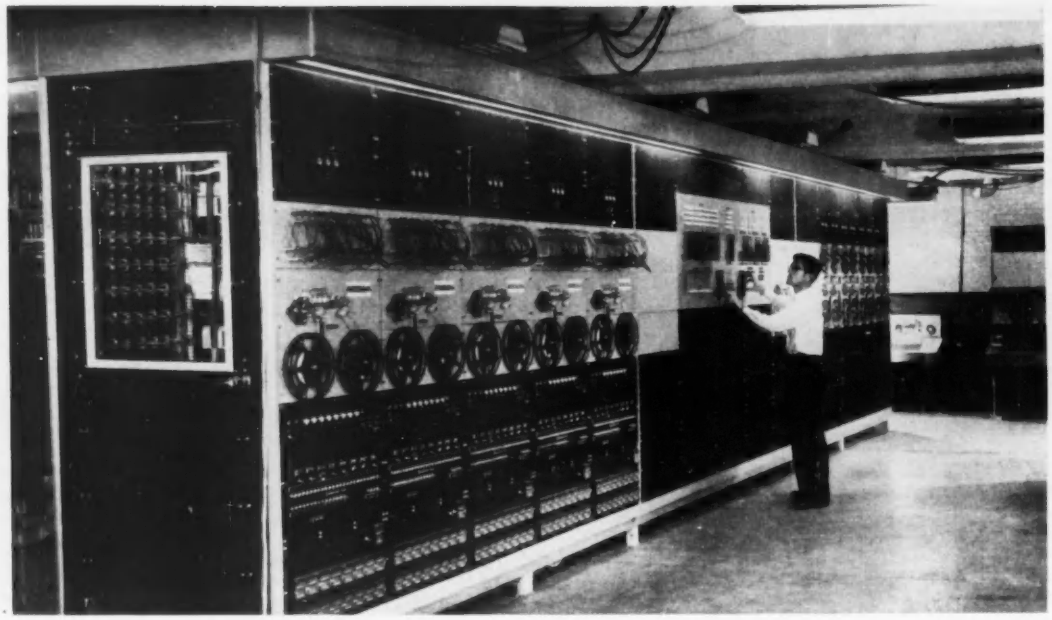
Existing Computers

It is, thus, seen that large-scale automatic digital computers, especially the electronic type, show the most promise. Of these, there are three in this country which have been in operation long enough to provide operational experience. These are "ENIAC", built by the University of Pennsylvania for the Army Ordnance Department, operating since 1946; "SSEC", built by the International Business Machines Corporation in New York City, operating since 1948; and "SEAC", built by the National Bureau of Standards, Washington, D. C., operating since 1950.

At the time of this writing, two or three other machines are being put into operation and a number of others are in various stages of design, construction, or testing. In England one large electronic digital machine (EDSAC; Cambridge University) has been in operation since 1949. Several others are under construction. Most other European countries are developing electronic machines. In this country most of the computing machine development is Government-financed. A number of different Federal agencies are acting as sponsors. The National Bureau of Standards, in addition to building two machines of its own, has acted as technical monitor in many procurement contracts for other Government agencies.

Components of Automatic Digital Machines

There are certain functions which every digital computer must perform in solving a computational problem. First, the computer must accept in-



BUILT BY HARVARD UNIVERSITY, the "Mark III" computer is now operated by the Navy's Bureau of Ordnance. The computing section of the machine can multiply two 16 digit numbers in about 12 thousandths of a second. It can add these figures in one-third of that time. Faster machines are expected.

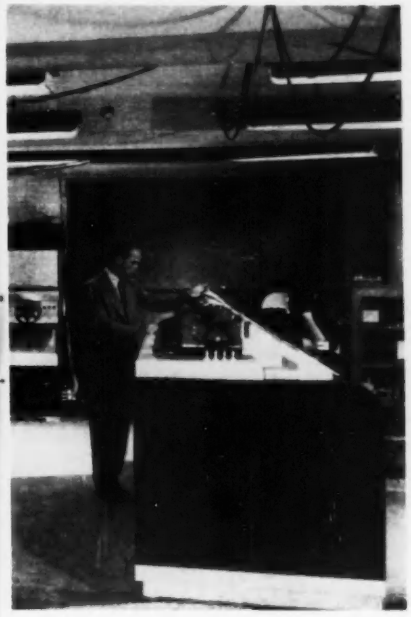
structions as to the operations of which the problem consists, as well as any initial numerical data, such as coefficients, parameters, and known boundary values. Second, these data must be stored in the machine to be available during the computation. Third, the machine must carry out arithmetic operations and certain simple logical operations. These include transferring numbers from one storage location to another; isolating certain digits or the sign of a number; and choosing the next operation to be performed from two or more alternatives depending on the sign or magnitude of a previously computed number. Furthermore, it is desirable that the machine be capable of modifying the instructions originally inserted. The results of intermediate arithmetic operations must also be stored for further reference. Finally, the desired end results must be communicated to the machine operator. During the complete cycle, the machine must be guided automatically from one instruction to the next, using in sequence the orders which are stored in it. The functions enumerated are embodied in separate machine components called, respectively, input organ, storage, arithmetic organ, output organ, and control.

The inconspicuous function of number storage or "memory" is the decisive one in the design of a machine. In most modern machines, instructions are coded in the form of numbers and are stored in the machine in the same way as other numbers. For general-purpose computing a machine needs storage capacity for at least several hundred, and preferably several thousand numbers. To accommodate this amount of storage in a form suitable for quick access is a major problem.

Several storage media are being used or developed. One uses magnetized spots on the metallic surface of a rotating drum, disk, or tape. Another employs sound waves travelling in a column of mercury. The sound waves are converted to electric pulses by a piezoelectric crystal at the end of the column; conducted back to the beginning of the column by a circuit, which also regenerates their shape and timing; reconverted into sound waves; and, so, circulated continuously until the machine calls for information and the recirculation circuit is opened. Finally, there are several variations of electrostatic storage on the screen of electron beam tubes. The latter type of storage is very promising, but it has not yet been tested in actual large-scale computer operation.

Machines with mercury memory have been operated successfully for some time. This type of memory is a little slower than electrostatic storage, requiring somewhat longer to transfer a desired number from storage into the machine circuits. However, the loss of time is not prohibitive. Magnetic storage is comparatively slow, but has the advantage of low cost. Where a storage capacity of more than a few thousand numbers is desired, a magnetic medium is, at present, the one economical way of achieving it. The development of these storage devices has made obsolete the older elements, like counter wheels, relays and ordinary vacuum tube circuits, which are still in use in most existing machines.

The arithmetic organ, which is the most important part of the machine from the logical point of view, is relatively simple engineering-wise. No entirely new elements are required. Conventional electronic circuits of moderate size containing, perhaps, a few hundred vacuum tubes and/or several thousand germanium diodes, can be designed which will perform the usual arithmetic operations at the desired high speeds. Several existing machines accomplish the multiplication of two numbers, each having between 10 and 13 decimal digits, in a few milliseconds. This speed could easily be increased by a factor of about 100, by introducing multiple circuits op-



erating in parallel and by a conservative increase in the pulse rate. The cost of such machines would be increased, but not prohibitively. But, in present day machines, a further increase in computing speed would be of little use as long as the memory organs were not made faster.

The control organ, like the arithmetic one, is complicated as far as the logical arrangement of circuits is concerned but presents relatively few engineering difficulties. The function of this section of the computer may be described as one of traffic control. By opening and closing "gates" in circuits, the control organ does the following: dispatches at the proper time, selected numbers from the memory to the arithmetic organ where they are operated on; activates those portions of the arithmetic unit which are required for the operation being performed, and shuts off all other arithmetic circuits; dispatches the results of the operation from the arithmetic organ to the memory; and dispatches the next instruction from the memory to the control organ.

The input and output organs have received less attention from designers than any of the other machine elements. Consequently, they are still in a rudimentary stage. Some existing machines use punched cards or perforated paper tape for both input and output. In addition, the computers can be equipped with typewriters that put the machine output directly into printed form. Otherwise, the perforated cards or tape must be passed through appropriate typewriters which are separate from the computing machine itself. The speeds of all these media are inadequate compared with the computing speeds of modern machines. Magnetic media are just beginning to be used for both input and output. The speed of these devices is a little more adequate, but they have been in operation for such a short time that it is not yet possible to form any judgment about performance.

If input and output are on either perforated or magnetized tape, numbers computed in the course of a problem can be recorded on the tape and, later in the same problem, fed back into the machine for further use. Thus, the input and output media can be used for storage in addition to the memory organ proper. This method of number storage is usually called "external storage" in contrast to internal storage in the memory organ.

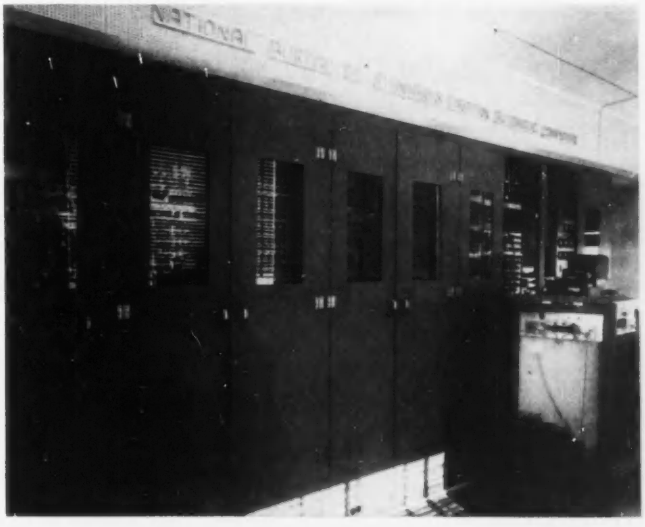
Applications of Automatic Machines

Engineers are only beginning to explore the rim of the vast territory which the new machines promise to open up. In these first few years, the machines have for the most part been applied to the same kinds of problems as before—only more of them. But here and there entirely new uses have been attempted.

Probably the greatest strides have been in the field of partial differential equations. Such equations occur in calculations of electro-magnetic fields, of the flow of liquids or gases through nozzles or around moving objects (ships, airplane wings, missiles), of the flow of heat through insulating layers or in burning or exploding substances, of elastic stresses and vibrations in solids, of the wave functions of nuclear physics, and so on. While the numerical integration of ordinary differential equations had been a fairly common undertaking before the advent of high-speed computing, partial differential equations were hardly ever attacked. The reason is easy to understand.

Assume that in solving a given ordinary differential equation the required accuracy can be obtained by stepwise numerical integration using, perhaps, 50 steps. It would be reasonable to estimate that under similar circumstances a partial differential equation in two variables will require 50x50 or 2,500 steps. Sometimes, this is actually the case. But, for reasons well understood by mathematicians, the required number of steps is usually nearer 50,000. This number makes computation almost impractical with any but the most modern equipment. The computations are still more voluminous for systems of simultaneous

FRONT VIEW OF SEAC, the National Bureau of Standards Eastern Automatic Computer. This machine was the first postwar automatically-sequenced high speed electronic computer to be put into productive operation. A tape memory unit was recently added as part of a continuing development program.



partial differential equations, or for equations in more than two independent variables.

High-speed computing machines, on the other hand, can handle equations in two variables as a matter of course. Equations in three variables can be accommodated quite well if the equations are not too complicated. Beyond this point, stepwise integration is hardly possible even with these machines. Here, however, an entirely new approach, which has been developed only in the past few years under the name of "sampling methods," becomes efficient. These methods are not yet fully explored, but they do promise to make possible the solution, on high-speed computers, of partial differential equations even in a large number of dimensions.

Constant users of ordinary differential equations originally gave rise to the development of the large digital machines. More specifically, this development was caused by the growing demand of the armed forces for the computations of trajectories of shells, bombs, and rockets. This demand soon outstripped not only the capacity of manual computers but even that of differential analyzers, which were tailor-made for the purpose. Today such trajectories are computed wholesale on electronic digital machines. These machines can accommodate differential equations of much higher order, say 20 or 30, which occasionally arise in control or other problems. These high-order equations could not possibly be undertaken on any other kind of equipment.

The solution of systems of simultaneous algebraic equations is a frequent requirement. These equations are encountered, for example, in the computation of equilibrium conditions in reversible chemical reactions. Here, the solution for a single case or for a modest number of cases could well be found by manual computation. The new machines come into the picture mainly where a large number of cases is to be treated.

The U. S. Bureau of Mines is making use of large-scale electronic machines in the study of the combustion of petroleum products under every conceivable combination of circumstances. The equations in this case are non-linear. Systems of linear equations are much more frequent and are familiar to experimental scientists and statisticians because of their application in the method of least squares. Here systems of several hundred equations seem to be well within reach of high-speed machines. Without them, the solution of anything above order 20 or so is impractical.

The evaluation of a particular mathematical function is a suitable task for the new machines if the number of cases (i.e., different values of the independent variables and parameters of the problem) is large; or, if the functions are very complicated; or, if they have to be computed by processes involving many computing steps, such as slowly convergent series or numerical quadratures. Applications are numerous. The new computer is of great advantage in two special cases of quadratures. The first class are multiple integrals, which are calculated either by stepwise integration or, if the number of dimensions is large, by the "sampling method" mentioned before. The second special type consists of Fourier transforms, which are of such great importance (for example, in crystallography) that special analogue machines have been built to deal with them. Related to Fourier transforms and encountered even more frequently is the simpler problem of autocorrelation, which is eminently suitable for high-speed machines.

The applications enumerated so far are predominantly scientific in origin and mathematical in character. These, however, account for only a fraction of the work which automatic digital computers will eventually perform. At least as important as their applications to science and engineering are those to problems of control and management.

Analogue computers for fire control of guns have already been mentioned. It is possible to use digital computers, not only for fire control but for the more complicated problems such as steering missiles or planes to a desired destination, or for traffic control at airports. Possible non-mathematical applications are the administration of vast files of records, such as are maintained in insurance companies, governmental agencies, mail order houses and libraries; large statistical operations like those of the Census Bureau; or the planning and programming of large business or governmental operations. It is evident that in all these applications the machine is not so much concerned with computation as with the handling of information. Even the best of our present machines are not too well adapted to these problems, so there is much development yet to be done.

New Ceramic Withstands Thermal Shock

A SERIES of new ceramic materials able to withstand extreme thermal shock—primarily through exceptionally low coefficients of expansion—has been developed by Stupakoff Ceramic & Manufacturing Company, Latrobe, Pa. Identified as Stupalith, this material is being produced commercially in two principle types: with "zero" thermal expansion and with near-zero thermal expansion, either plus or minus.

The ability of Stupalith to resist expansion or contraction with changes in temperature has been illustrated by a series of tests in which a sample was heated to 2,000 F and plunged into liquid air, with the cycle being repeated 100 times without harm.

Basically a wide series of lithium aluminosilicate compositions, the Stupalith group ranges from oxide compositions equivalent to the mineral eucryptite, through the mineral petalite. Certain other compositions closely allied to lithium aluminatesilica also are part of the group.

Made from plentiful and nonrestricted raw materials, Stupalith can be formed by pressing, extruding, casting and ramming. It can be press molded into tiny parts weighing a fraction of an ounce, as well as rammed or cast into large items weighing several pounds. By machining or grinding after firing, the dimensions of Stupalith parts can be held to precise dimensional tolerances. It can be used at temperatures up to 2,400 F, and is believed by the manufacturer to remain stable indefinitely. Samples have been held at 2,000 F for periods of 30, 60, 90 and 120 days with no detectable changes in specific gravity.

Its ability to withstand thermal shock makes it particularly adaptable for pickling bath containers, kiln furniture, induction heating, high temperature jigs and wire wound coil forms.

Parts made from "zero" expansion Stupalith can be used for plug-and-ring gages, mirrors, turbine blades and jet turbines, engine parts and nozzle inserts. Stupalith in its various forms is recommended by the manufacturer for pouring ladles for metals, electronic insulators, laboratory combustion boats and tubes, overflame cooking ware, dilatometer tubes and rods, thermocouple tubes and other applications requiring low thermal expansion or thermal shock resistance.

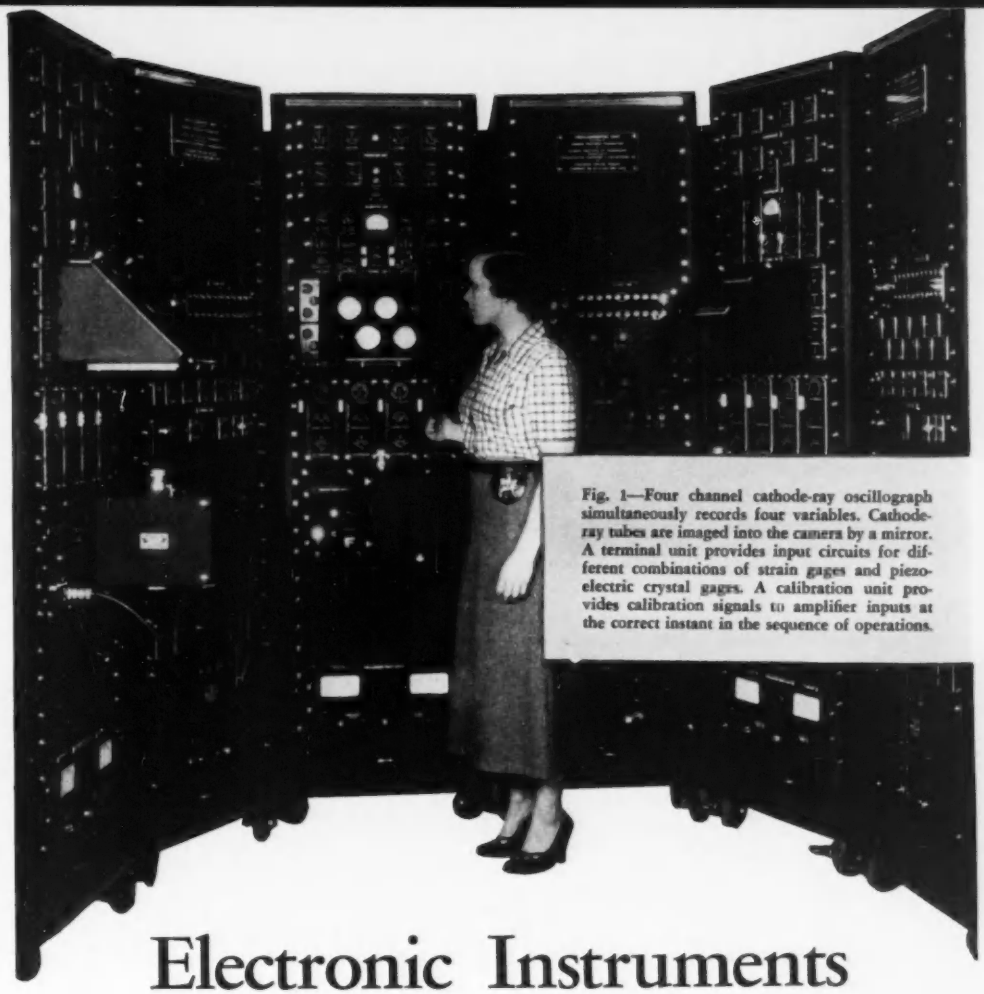


Fig. 1—Four channel cathode-ray oscillograph simultaneously records four variables. Cathode-ray tubes are imaged into the camera by a mirror. A terminal unit provides input circuits for different combinations of strain gages and piezoelectric crystal gages. A calibration unit provides calibration signals to amplifier inputs at the correct instant in the sequence of operations.

Electronic Instruments For Mechanical Measurements

J. L. MURPHY

Assistant Chairman, Communication and Computer Systems
Armour Research Foundation of Illinois Institute of Technology

THROUGH THE UTILIZATION of its principles and associated apparatus, electronics has made many important contributions to the field of mechanical measurements in the last two decades. Much of the progress in achieving faster and lighter aircraft, and smaller, more efficient, safer, and less expensive machines of all types has to a large extent resulted from data obtained by electronic techniques and instrumentation.

Many organizations devoted to the manufacture or development of structures and machines have engineering departments that include electronic engineers. It is the duty of these engineers to devise special apparatus for making measurements on special jobs. For small organizations, a large variety of commercial equipment is available that any qualified engineer can set up.

For unusual problems, the services of manufacturers of equipment are available. When commercial equipment is not applicable for dealing with specialized complex problems, one of many laboratories can be engaged to develop satisfactory apparatus.

While the following discussion deals with instrumentation for measuring strain, it should be understood that by proper design the strain in a gage can be proportional to basic mechanical quantities such as displacement, velocity, acceleration, torque, force, and temperature.

The usual limitation in applying

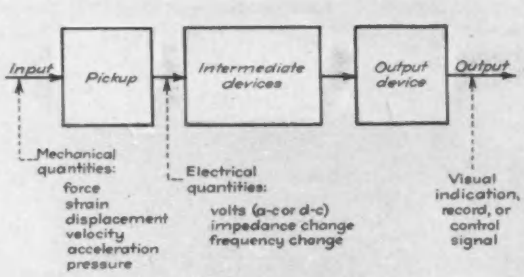


Fig. 2—Basic measuring system comprises a pickup gage, intermediate device for amplifying gage signal, and an output device for visual indication or record.

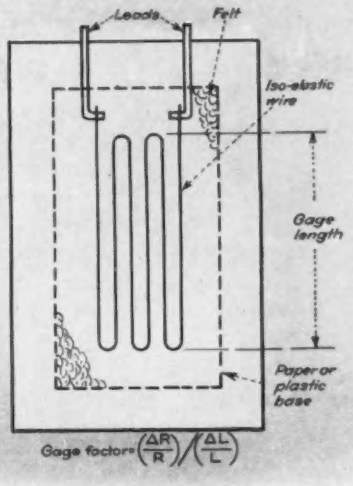


Fig. 3—Construction of a typical resistance strain gage. Stretching the gage increases its resistance as a result of increase in wire length and reduction in wire diameter.

electronic techniques to obtain mechanical measurements is not in the electronic apparatus. The limitation is in the device for converting mechanical information into an electrical form that can be supplied to the electronic equipment.

For a device or an instrument to be effective when used as a gage, the relationship between its electrical output to mechanical input must be "in proportion" or linear. One problem of gage design is to produce the necessary sensitivity without exceeding the region of linear relationship of output to input.

In general as indicated in Fig. 2, the basic electronic measuring system consists of at least three elements:

1. A pickup or sensing element, which gives an electrical signal that indicates any change in an electrical property related to the mechanical quantity under consideration.

2. Intermediate device, such as an amplifier or modulation system.

3. An indicator or recorder, which conveys the result of the process to the observer.

Some systems that employ frequency-modulation or amplitude modulation techniques, include electronic components such as oscillators, discriminators, modulators or demodulators between the pickup and output device.

When setting out to solve a measurement problem by electronic techniques, the engineer will find that pickups or sensing elements fall into two categories: Impedance variation, and energy generating.

Impedance variation sensing elements include those in which the resistance, inductance, or capacitance can be caused to vary in proportion to the applied mechanical quantity being measured. In this class of pickup devices, specialized mechanical arrangements are necessary to produce the desired electrical result.

The energy generating class of pickup or detecting devices include two categories: Electrostatic, and electromagnetic. In both a mechanical quantity generates a voltage as the direct result of natural phenomena or laws of electricity.

A piezoelectric crystal is an electrostatic pickup that generates an electric charge when subjected to pressure.

The electromagnetic pickup consists of a set of electrical conductors arranged to move at right angles through a magnetic field. The voltage produced across the terminals of the conductors is proportional to the velocity of their motion through the field. This pickup therefore is limited to the measurement of instantaneous relative velocity of the conductors to the field. The conductors are mounted on a mass, which must necessarily have a spring support, but when the natural frequency of the combination is low, the voltage is a true representation of the relative velocity.

Sensing Elements

In the typical resistance strain gage, a fine wire is laid back and forth several times on a tough paper or plastic base and covered with felt for mechanical protection as shown in Fig. 3. This gage is mounted with its long dimension in the direction of the strain to be measured. As the gage is stretched, its resistance increases as a result of the increase in wire length and the accompanying reduction in cross-sectional area.

Commercial strain gages exhibit a percentage change in resistance of

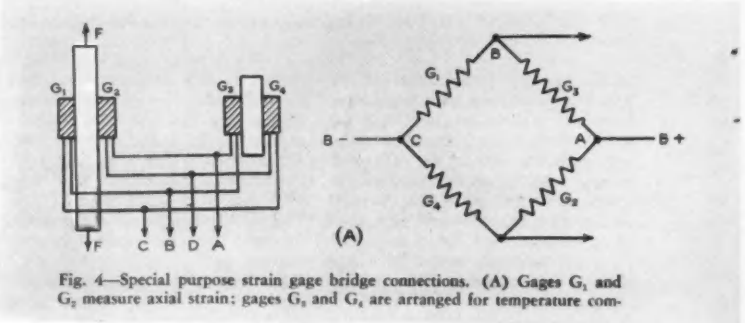


Fig. 4—Special purpose strain gage bridge connections. (A) Gages G_1 and G_2 measure axial strain; gages G_3 and G_4 are arranged for temperature com-

from 2 to 4 times the percentage change in elongation, depending upon the wire and base materials used.

Although strain gages actually measure strain, their major application is the measurement of stress, which is obtained from the measured strain and the elastic modulus of the material on which the gage is mounted.

Resistance strain gages probably represent the most common application of electronic techniques to mechanical measurements. Because of the necessity for minimizing structural weight, aircraft design is responsible for an enormous annual consumption of gages. Before a plane goes into production, thousands of strain gages are mounted on the structural members of test models, and data taken on flight tests by multiple channel recorders.

Combinations of strain gages can be connected to cancel out certain undesired components of stress present in a member. In Fig. 4 (A) is shown a bridge connection in which two gages measure axial strain, and in which two additional gages are arranged for temperature compensation. Since the measuring gages are connected to opposite bridge arms, an increase or decrease in either will produce identical outputs, and a decrease in one resistance equal to an increase in the other will cancel in the output. Therefore if the two gages are connected to opposite sides of a structural member, any bending effects will be cancelled in the bridge output; while the axial tension or compression will produce additive outputs from the bridge, doubling the sensitivity over that which would be obtained with a single "active" gage.

To be effective, the temperature compensating gages must be unstressed, and must be mounted on similar material placed as closely as possible to the active gages so their temperatures will be identical.

A variant of this connection is shown in Fig. 4 (B), where the two "active" gages are connected in adjacent arms of the bridge. In this arrangement, the axial strains cancel and the outputs of the two gages resulting from bending are additive.

Bridge circuits such as those shown in Figs. 4 (A) and (B) are simple examples of computing circuits in which an undesired effect is subtracted prior to amplification and recording. In such circuits if the two active gages remain at the same temperature, the temperature compensating gages can be replaced by resistors in the electronic apparatus.

In Fig. 4 (C) is shown a bridge connection of four active gages for the measurement of torque in a shaft. The gages are cemented on 45 deg helices, the lines of maximum tension and compression. The two gages along the line of tension are connected in opposite bridge arms, as are the pair mounted along the line of compression. With this connection, the output resulting from torque in either direction is four times that obtained by a single gage along one of the lines and three "dummy gages".

A further advantage of the connection shown in Fig. 4 (C) is that the effects of axial strains are completely cancelled out, as are temperature effects if the temperature is equal at all gages. Bending effects are also nullified if the gages are mounted symmetrically in pairs on opposite sides of the shaft, a pair consisting of one tension and one compression gage.

In practice many strain gages are applied to a machine under test in any of the combinations described. Points of critical strain may be selected and the effects of different types and magnitudes of loading investigated either statically or dynamically.

Other impedance variation sensing devices are those of capacitance variation, inductance variation, and an alternate form of the latter, magnetostriction. The magnetostriction phenomenon consists in a change in the magnetic permeability of a ferrous metal when stressed.

For this discussion, impedance is defined as an opposition to the flow of electrical current. The term impedance variation, therefore, implies a varying opposition to a current flow, which by suitable electronic instruments can be detected as a change in either voltage or current through the device, depending on the detailed circuit arrangements.

The capacitance gage, Fig. 5, is most readily adaptable to the measurement of a displacement. This gage is used in applications in which the desired mechanical variable can be converted to a proportional displacement. The

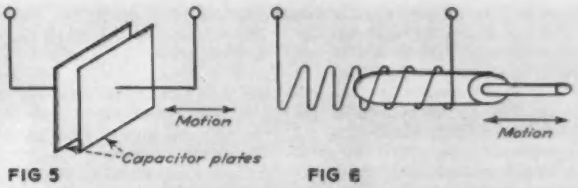
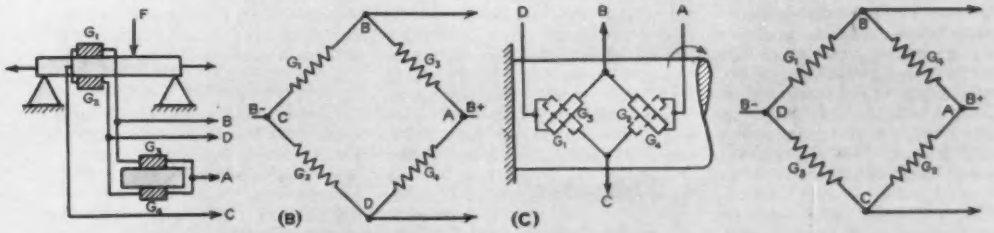


FIG 5 FIG 6

Fig. 5—Variable capacitance pickup; changing the spacing between the two plates changes their capacitance. Fig. 6—Variable inductance pickup; moving the core in or out of the coil changes the reluctance of the coil.



pensation. (B) Additive arrangement for bending strains and for canceling axial strains. (C) Arrangement for torque measurement. Gages are cemented on shaft along the lines of maximum tension and compression stresses.

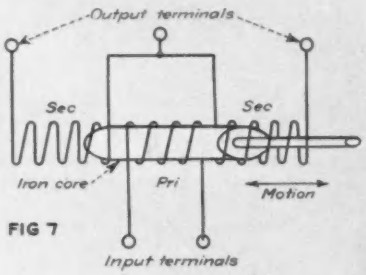


FIG 7

Fig. 7 — Variable-coupling inductance pickup; changing the position of the plunger changes the magnetic coupling of the center coil to the end coils.

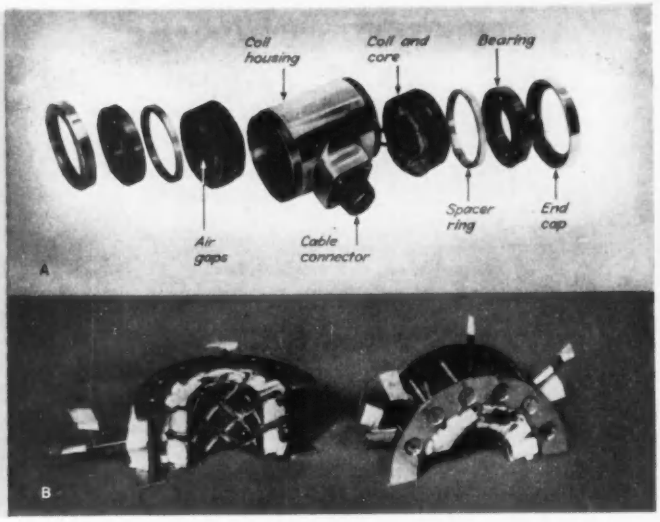


Fig. 8—Torque pickup units in which magneto-striction generates signals. (A) Two pickup coils each with an independent core. (B) Pickup coils superimposed.

gage consists essentially of two metal plates separated by as small a distance as is feasible for the given application. The difference in measured capacitance between these two plates gives an indication of the displacement in their spacing.

In many applications, one of the plates can be a moving element so that the variation in capacitance gives the motion of the element directly. In applications where the moving plate is a seismic mass (such as a weight mounted on springs) the change in capacitance, being proportional to displacement, is directly related to the acceleration applied to the mass and spring assembly.

A further application of the capacitance variation pickup is in the measurement of transient pressures, in which one plate of the condenser is a stretched diaphragm. When pressure is applied to the back of the diaphragm, the bending produced across the face changes the spacing between the capacitor elements. Device is used for measuring pressure in gun barrels.

In elementary form the variable inductance pickup, Fig. 6, consists of a coil surrounding a core of magnetic material. Moving the core of high permeability in or out changes the reluctance, or magnetic resistance, of the magnetic circuit to the passage of magnetic flux lines. This change in reluctance changes the inductance of the coil, which can be measured either by an inductance bridge circuit or as a frequency change in an oscillator using the coil as a frequency determining element.

Another more common type of pickup, available in several commercial models, operates by changing the coupling between coils. This "variable-coupling" pickup, Fig. 7, consists essentially of three concentric cylindrical coils, a return circuit of magnetic iron around them, and a plunger of magnetic material.

The center coil when excited by a generator of suitable frequency induces a voltage in the two end coils. This voltage is changed by changes in the position of the center core. Ordinarily with no applied force, displacement, or pressure the two outer coils give zero output when connected as two adjacent arms of a bridge circuit. Then when the measured phenomenon changes the position of the core, the bridge is unbalanced in either the positive or negative direction giving a proportional output, which may also indicate the sign of the phenomenon.

In a third type of variable-inductance pickup, the variation is produced by magnetostriction, which changes the magnetic permeability of the iron as a result of applied strain. Since stress and strain are related by the elastic modulus, the permeability change is directly proportional to applied stress over the range of linearity.

A torquemeter that utilizes magnetostriction for the generation of signals has been developed by Armour Research Foundation. This torquemeter makes slip rings unnecessary and can be applied to a variety of shaft materials. The pickup head is designed to observe the effective permeability along the lines of maximum tensile and compressive strains, which are 45 deg helices on the surface of the shaft.

In this torquemeter pickup, coils with air gaps between them along the lines of maximum strain are assembled in an iron core as shown in Fig. 8. The inductance of one set of coils is affected by the lines of tension and the other by lines of compression, thus the instrument when connected in a bridge circuit can be basically balanced in that an output appears only when torque is applied to the shaft.

In a torque measurement set up, no connections are made to the shaft. The only mechanical requirement is that a pair of bearings support the instrument so that an air gap, of the order of 0.010 in., be maintained between the magnetic core and the shaft surface.

This torquemeter principle, of course, can be applied to the measurement of tension or compression in a straight section of magnetic material, by connecting two coils surrounding the material into opposite arms of a bridge the output of which will then be proportional to stress. The two signs of stress can be differentiated by suitable design of the circuitry. If the sign is always known, certain simplifications can be made.

Voltage Generating Devices

In piezoelectric devices, a voltage is generated by a crystal when pressure is applied to its two opposite surfaces. With suitable electrodes such as metal foil, this voltage may be picked up and fed to a suitable amplifier. Fig. 9 shows a schematic of such a gage.

Piezoelectric crystals are used commonly for the measurement of pressure, stress, and strain. They are par-

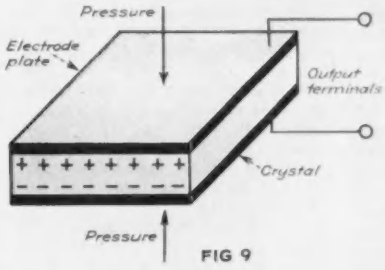


FIG 9

Fig. 9—Piezoelectric pickup; voltage is generated when pressure is applied to the crystal.

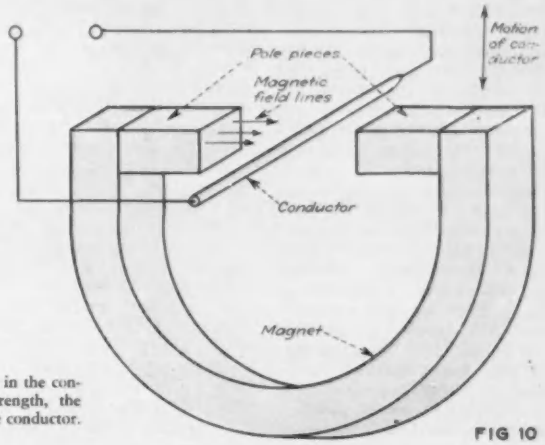


FIG 10

Fig. 10—Electromagnetic pickup; voltage induced in the conductor is proportional to the magnetic field strength, the number of conductor turns, and the velocity of the conductor.

ticularly adapted to the measurement of fluid pressure, in either air or liquids, since a pressure in the surrounding medium acting on all surfaces of a crystal will produce an output.

In measurement of strain in rotating machinery, the high voltage output of the crystal gage and its high impedance level result in a minimum of noise introduced by any slip rings and brushes needed to connect the gage to the measuring equipment. For many applications, however, the usefulness of crystal gages is limited by their high sensitivity to stray electrostatic pickup.

The crystal gage is most useful when used with a short cable because the shunting effect of the cable capacity reduces the output voltage, and when used in a space relatively free from noise sources. The gage is simply connected to the output of an amplifier of suitable gain and frequency response.

The electromagnetic type of self-generating pickup depends upon the induction of a voltage in an electrical conductor by motion at right angles to a magnetic field as indicated in Fig. 10. The induced voltage is a linear function of the magnetic field strength, the number of effective turns of the conductor, and the velocity of the conductor relative to the magnetic field.

In one simple configuration of the electromagnetic self-generating pickup, the velocity gage, the conductors are attached to a mass that is supported with light springs so as to give the assembly a low mechanical resonant frequency compared to the frequencies to be measured; the output then is directly proportional to velocity. This arrangement implies that the mass remains in substantially the same position while the magnet moves relative to it. The magnetic field is usually created by a permanent magnet, which may be attached to the case in which the gage is mounted.

An alternative arrangement has the coil attached to the core and the magnet is mounted on springs. With this type of gage, acceleration and displacement for short periods of time or for sinusoidal motion can be obtained easily by differentiating or integrating the output voltage respectively.

Intermediate Devices

The following discussion of intermediate devices is limited to general systems, and touches only briefly where necessary on output indicating devices.

The function of the intermediate electronic devices is to modify the gage output in such a way that the output device, which is an indicating or recording instrument, gives the magnitude of the measured variable.

A simple electronic system consists of an amplifier to raise the pickup voltage to a level sufficiently high to actuate the indicator. In more elaborate or special purpose instruments, the relationship of output voltage to the measured variable may not be so simple but may require further electronic operations before the desired output relationship to the variable is obtained.

Since the Wheatstone bridge circuit is essentially a means of impedance measurement, the basic information on bridge connections as described in the discussion on strain gages is applicable to all the impedance-variation pickup devices.

As an example of an elementary type of electronic measuring system consider a strain gage bridge, with one or more active gages, connected to a direct-coupled amplifier (one that will pass a d-c signal). When the gage bridge is unbalanced because of application of strain, the function of the amplifier is to amplify the voltage at the output terminals of the bridge to a value sufficient to actuate a voltmeter, oscilloscope or galvanometer connected to its output.

Since it is responsive to direct current, this system gives a constant voltage output for a constant strain and, of course, follows varying strains up to the upper frequency limit of the amplifying system. This system is difficult to use in practice because by its nature it indicates slow drifts of the bridge output caused by temperature differentials and drifts in the amplifier tube currents, which appear as spurious signals.

Where static or zero-frequency response is not necessary, a more practical arrangement consists of an a-c amplifier designed to pass all the frequencies present in the phenomena applied to the bridge. Since slow drifts in the gages or amplifier are outside the frequency response band of such an amplifier, the drifts do not appear in the output. A second-order error in bridge output is present when the bridge is not balanced at zero strain, and a reasonably close balance of the bridge is still necessary for maximum accuracy. This technique is applicable

for signals of frequencies higher than a few cycles per second.

The four-channel oscillographs shown in Fig. 1 incorporate direct-coupled amplifiers together with a-c preamplifiers. For most applications of strain gages, the direct-coupled amplifiers provide sufficient gain.

A common variation of the simple d-c or low-frequency a-c amplifier is the integrating amplifier that contains electrical networks to integrate the voltage wave delivered by the gage. This type of amplifier is used primarily with accelerometers and velocity gages to give outputs proportional to velocity and displacement, respectively.

The accelerometer most frequently used with the integrating amplifier is of the resistance strain gage type excited with direct current, so that the output is proportional to the acceleration producing the resistance change.

The velocity gage best suited for the technique is the electromagnetic self-generating type in which the induced voltage is proportional to velocity.

The output of an integrating amplifier may be utilized in any of the ways that a straightforward d-c or a-c amplifier output is used. A change-over from integrating to linear amplification can be made with a switch, enabling a single amplifier to serve either purpose as needed.

A further extension of this process leads to the amplitude-modulation system, in which alternating current of suitable frequency is applied to the bridge instead of direct current. The alternating current frequency must be of the order of ten times that of the highest frequency component to be measured to produce good signal-to-noise ratio. In this arrangement, the amplifier must pass only the so-called carrier frequency of the alternating current plus side-bands (frequency ranges on either side of the carrier), which are determined by the frequency range of the measured phenomena. As a rough rule, the total amplifier bandwidth necessary is at least twice the highest frequency present in the phenomena to be measured.

In the amplitude-modulation system when the bridge is at balance the output is zero; but when unbalanced by the application of strain, the output is a sine wave of a carrier frequency, the amplitude of which is proportional to the unbalance of the bridge. The sign of the strain will not be indicated when only an amplifier and simple detector or a-c voltmeter are used, unless the bridge is arbitrarily unbalanced in a known direction in the absence of strain. For applications in which the strain may be of either sign the phase-sensitive detector offers better stability.

The output of an amplitude-modulation system can be fed to any of the indicating or recording instruments mentioned in the following discussion of output devices, but for the measurement of static strain only an indicating voltmeter is necessary. For unidirectional strain, the carrier-frequency output can be presented on an oscilloscope for photographing, in which event the amplitude of the carrier voltage at any instant is a measure of the instantaneous strain at that instant.

The d-c amplifier is applicable only to resistance-variation gages. Capacitance and inductance-variation devices are operable only with alternating current, and therefore can be used to advantage with the carrier system of amplitude modulation. With such instruments the bridge circuit is usually made up of four reactances, one or two of which are elements of the gage.

In addition to the methods already cited, the advent of frequency modulation in the field of radio broadcasting has supplied a valuable means of obtaining data. Broadcasting techniques have had to be greatly modified to adapt them to the many individual problems and types of gages that are encountered in the development of a measuring system for a specific problem.

Frequency modulation may be desirable in achieving one of two objectives: Recording for later playback; and for indicating or recording from a gage that lends itself to the production of an FM signal. Most capacitance gages and some applications of variable-inductance gages offer greatest overall accuracy and simplicity when used with an FM system.

The variable impedance class of pickups is well-suited to FM systems, since reactances can be readily utilized to produce a frequency change proportional to the reactance change. Such a circuit is an oscillator in which frequency is determined by the combination of a coil and condenser, with a variable reactance pickup connected as one of these elements. When the variable being measured is at its zero or static value, the frequency of the oscillator is constant at some preset value, and a change in the variable produces a corresponding change in frequency.

This frequency modulation technique is applied most frequently with capacitance variation gages, and to a lesser extent with inductance variation. The reason for the latter is that the balanced transformer type of inductive pickup is quite accurate and simpler to apply with the amplitude modulated bridge technique.

The widespread applications for strain gages makes it logical to inquire as to the possible adaptation of FM techniques with this type of pickup. Unfortunately the percentage variation of resistance in a strain gage available within the limits of proportionality is of the order of one to two percent, whereas ten times this amount can be obtained with reactance-variation pickups, which thus give a much larger input to the electronic apparatus. In addition, circuit design for obtaining variable frequency from resistance variation is more difficult to accomplish than from reactance variation.

The maximum deviation of frequency from its center value, or percent modulation, should be large for greatest accuracy, since slow drifts of the oscillator and demodulator tuning are thereby minimized. The large variation in reactance aids greatly in obtaining the initial large frequency shift.

Simple reactance variation pickups are widely employed in telemetering data from missiles in systems using variable inductance pickups connected as frequency controlling elements in simple audio-frequency oscillators. A number of such oscillators operating at different frequencies are connected to modulate a single radio-frequency oscillator that broadcasts the signals to a convenient receiving and recording point. After reception, the signal is broken down into its audio-frequency components. These components are fed to separate discriminators giving voltage outputs proportional to the instantaneous deviation of the frequency from the center frequency.

Where it is possible to apply frequency modulation techniques simply, they offer many advantages in the way of stability, freedom from drift, ease of calibration, and linearity of signal output versus the signal input.

Output Devices

An output device converts suitable electrical signals to a form that can be interpreted by the observer. The desired output may be an indication on a meter or other such device, but is more commonly a permanent record of the phenomenon as a function of time. The latter, of course, is true of all variables that change too rapidly for human observation. In other instances, the output of electronic measuring systems may be an electrical signal for controlling the measured variable.

Indicating devices consist mainly of conventional electrical instruments that indicate the average voltage output of the instrumentation. Since they do indicate the average, they are suitable only for the measurement of static or steady-state quantities.

A d-c d'Arsonval meter is the most

common indicating device for measuring the amplified unbalance of a d-c bridge in a d-c amplifier system, in the rectified output of the carrier type of amplitude modulation system, and in the discriminator output of a frequency modulation system.

Where the resistance strain gage is used because of its sensitivity or small size, the output indicating instrument is frequently employed only as a balance indicator with a d-c amplifier; the actual reading being taken from a standard resistance connected as one of the measuring bridge arms. This setup, of course, requires adjusting the calibrated resistance to balance the bridge for each reading. The effect of variation in gain of the amplifier is eliminated by using it as a null indicator in this manner.

In a further variation of this use of the indicator, the amplified bridge output can be employed to actuate a motor to adjust the calibrated standard resistance to balance the bridge, and the reading taken from the position of the resistance shaft. By the addition of a pen and chart drive mechanism such a system can also serve as a recorder.

By far the widest application of electrical gaging methods is in fields requiring the measurements of those dynamic phenomena that occur too rapidly to be observed by the human eye. The common high-speed recording techniques for such purposes are based on the cathode ray tube.

The cathode ray tube produces a bright spot on a fluorescent screen in one end of the tube. The position of this spot is controlled in two perpendicular directions by the application of voltages to two pairs of deflecting plates. In the simpler applications one pair of these plates is not used, while upon the other is impressed a voltage proportional to the variable being measured; thus the deviation of the spot from its center position on the face of the tube is proportional to that variable. For other than static measurements, the displacement of the spot is ordinarily photographed on a film moving at right angles to the direction of the signal deflection. The processed film is a graph of the measured variable with respect to time.

In the four-channel oscillographic units, Fig. 1, this technique was used with four cathode-ray tubes being photographed by a single camera, giving four simultaneous records on one strip of standard 35 mm film as shown in Fig. 11. This record shows air blast pressures at four gage positions at different distances from the center of the blast. This technique is advantageous where the recording must be made over a relatively long time, or where it is desired to determine the precise instant at which a random phenomenon occurs.

Where the desired event can be located reasonably well in time, the recording process may be simplified by recording a single sweep of the cathode ray tube on a simple camera with the shutter open. This method requires, prior to the occurrence of the phenomenon, that a signal be available to "trigger" or start the sweep of the tube so that the phenomenon occurs during the trace swept out.

Commercial oscilloscopes with the necessary "single-sweep" provision and a trigger signal input, and cameras for the purpose are available. The latter consists of a suitable lens, shutter, film transport mechanism and a hood or other mounting brackets for attachment to the oscilloscope.

Dual channel oscilloscopes are also available for the simultaneous recording of two variables as a function of time on the same film. On a limited scale, six simultaneous traces can be obtained from a single cathode-ray tube having six electron guns.

A common means of recording the electrical signals from mechanical devices is the electromagnetic oscillograph, the galvanometers of which are basically the familiar d'Arsonval meter especially designed to have low inertia of the moving parts and springs stiff enough to produce a high resonant frequency. This frequency may be as high as several thousand cycles per second, but the sensitivity is much lower than that of the more common low-frequency galvanometers.

One group of direct-writing instruments use either ink or special paper that changes color when heated by the stylus, which is heated by passing a current through it. These have the drawback of being useful only up to frequencies of approximately 100 cycles per sec and many of them have adverse linearity characteristics.

Recent developments in magnetic recording have increased its adaptability for recording measurement data. It has found widest application where extreme compactness of the original recording equipment is necessary, and where it is possible to "play back" the magnetic record later into some form of permanent photographic record.

Another application of magnetic recording is to problems that require some form of computation apparatus prior to obtaining the ultimate record. In this technique, the play-back gives a voltage directly as an analog of the recorded phenomena. The overall electronic apparatus requirements for this system are considerably simpler than those needed for devices to read a record from photographic film and then convert that record to a voltage analog of the original recording.

One application of magnetic recording instrumentation developed at the Armour Research Foundation was a 100 channel recorder using a steel tape 6 in. wide to record guided missile data during flight. The record was recovered after parachuting it to the ground in a container. The record was then transcribed onto photographic paper by play-back into a magnetic oscillograph. In this example, the pickup devices produced frequency-modulation directly. A standard frequency was also recorded, so that corrections could be made for variations in the tape speed during either recording or play-back.

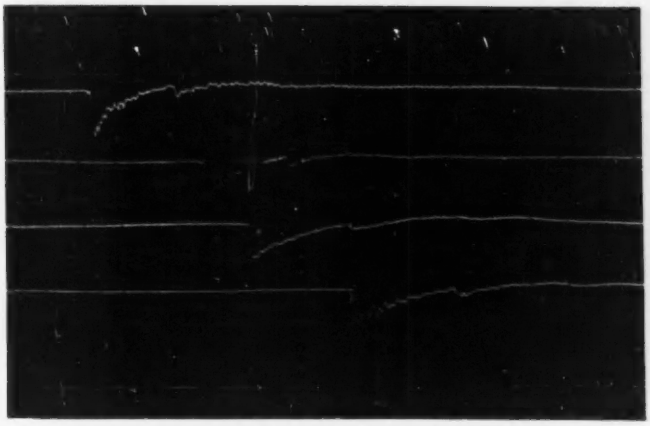
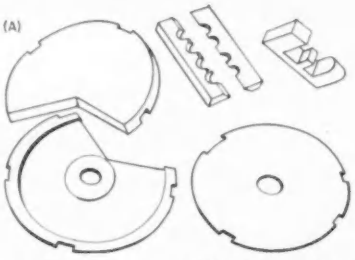


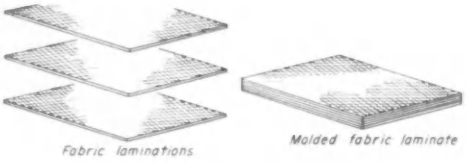
Fig. 11—Air blast pressures at different distances from the center of blast. The four simultaneous records were photographed on one film strip by a single camera.

Glass Fiber Reinforced Plastics

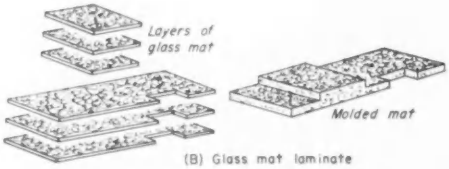
Effect of design procedures on properties and ease of fabrication. Recommended direction of loading in relation to laminations. How to handle reinforcements, attachments, undercuts, and hinged connections as recommended by designers of North American Aviation, Inc.



APPLICATIONS (A) Glass fiber reinforced plastics are contact or low pressure laminates that are especially practical when low quantities and/or complicated shapes must be molded. (see *Product Engineering*, Feb, 1951). Mat reinforcement is used when a low cost filler with good dimensional stability, high temperature resistance, and low moisture absorption is required.

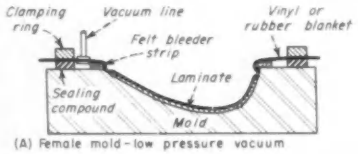


(A) Glass fabric laminate

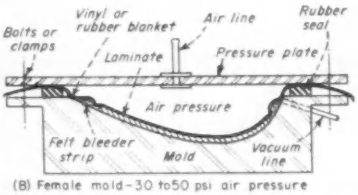


(B) Glass mat laminate

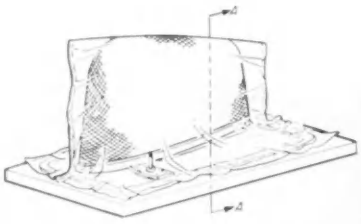
FORMS (A) Fabric laminates are composed of any number of laminate of glass fabric. Generally, only one type of fabric is used in a given part; however combinations of several fabric types may be employed to obtain specific effects. (B) Mat laminates are composed of glass mat bonded into any desired shape. The glass mat is generally used in sheet form. Such mat laminations cost less than woven fabrics, and can be felted in different patterns. (C) Shredded glass mat is often employed in molded form for complex shapes that would be difficult to obtain by lamination, and when uniform directional strength is



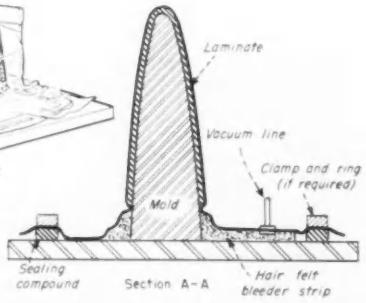
(A) Female mold-low pressure vacuum



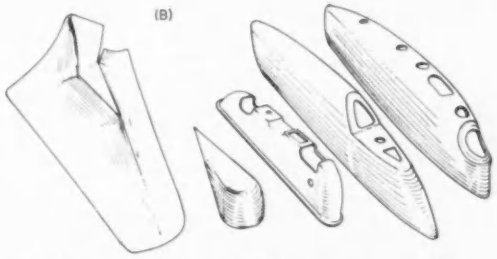
(B) Female mold-30 to50 psi air pressure

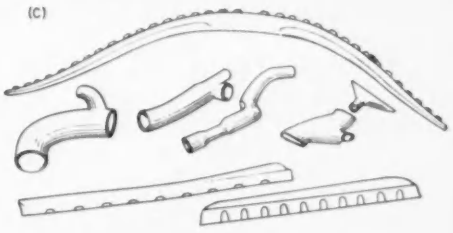


(C) Male mold-low pressure vacuum

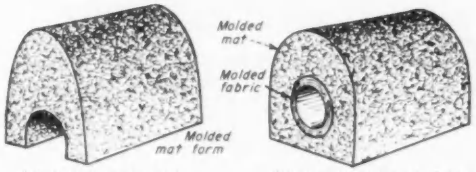


METHODS OF FABRICATION (A) This method of molding, using cast kirksite, cast aluminum, or electroformed nickel or copper dies, is used when average physical properties are satisfactory, when parts are of relatively simple shape, and when overlapped layers and wrinkles on the inner surface will not detract from performance or appearance. (B) Same as in previous method, except that higher physical properties are obtained due to higher molding pressures. Although those pressures are several times greater than required in "vacuum" techniques, they are still much lower than those required for compression molding of phenolics and related materials. (C) Utilizing the same die materials as in the former techniques, the shop applies this method of fabrication for parts that are narrow in relationship to length and depth and female molds would be impractical because of lay-up or uniform pressure application. (D) Dies for this method as made of conventional materials. Matched metal dies of rigid construction are generally used for parts not having great complexity

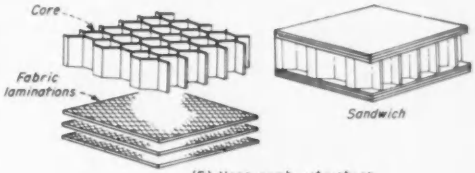




(B) Fabric reinforcements are applied for such parts as these dorsal fins, aileron caps, external bomb rack fairings and wings tips, or for other secondary structural members in which high specific strength is a primary consideration. Such woven fabrics are non-combustible; rot and mildew proof; temperature, chemical and solvent resistant; and dimensionally stable. (C) Because of their light weight and excellent thermal insulating characteristics, and because large complicated shapes can be fabricated economically in one piece, glass fiber materials are often used for heating and ventilating system ducts. If necessary in other applications metallic or non-metallic inserts can be molded in place, and low density cores can be incorporated in bonded sandwich structures. In applications such as these, square woven glass fabrics are usually specified, but glass mat, unidirectional glass fabric, or extra long weave fabrics may be better for other uses, depending on properties required.

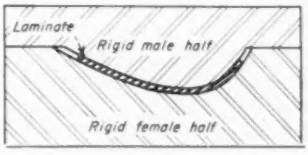


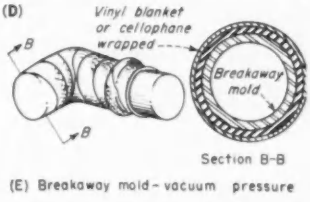
(C) Molded glass mat (D) Molded mat and fabric



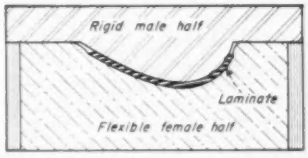
(E) Honeycomb structure

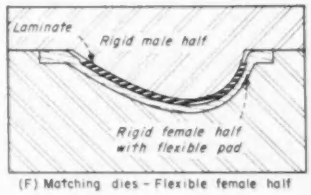
required in low cost-high production items. (D) Glass fabric laminations may be applied to mat laminated parts for local reinforcement. Glass mat also may be used as filler in glass fabric laminates. (E) Sandwich type laminates are composed of glass fabric laminate faces separated by a low density core. In this case, the core is honeycomb structure consisting of molded fabric laminations bonded together. Balsa wood and cellulose acetate also are often used for low density cores. Honeycomb constructions have been primarily associated with the aircraft industry as secondary load carrying structures.



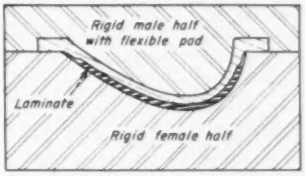


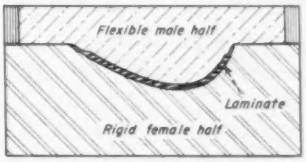
(E) Breakaway mold - vacuum pressure





(F) Matching dies - Flexible female half

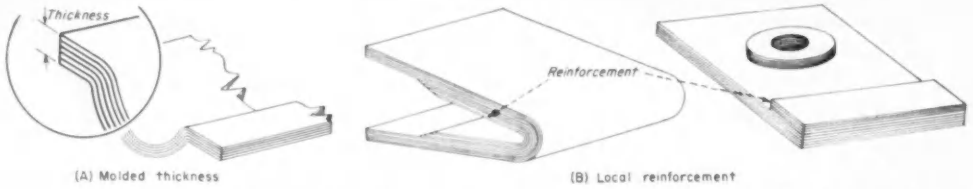




(G) Matching dies - Rigid female half

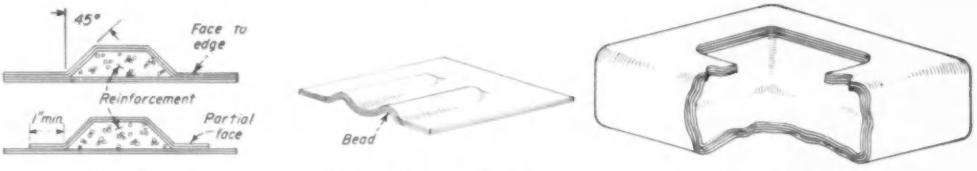
but which must be produced in fair sized quantities. As before, either glass mat or fabric parts can be molded. (E) Plaster of Paris is used as the mold material in this method. Only vacuum or wrapping pressure is required. Generally, a breakaway mold is used when only a few parts are required or when parts of complicated cross section, such as ducts, are to be molded. (F) The rigid male die of this set is made of kirksite, aluminum, or electroformed copper or nickel, but the female half either is made of a vinyl elastomer or rubber or has a vinyl or rubber pad. The smoothest surface on the molded part will be on that side formed against the male die. (G) Same as before, except the smoothest face on the part will be that formed against the female die. Either this or the previous method are generally used when matching dies are required, although tolerances are not as close as when no forming pad is used. As can readily be seen, the method of molding is governed by part shape, property requirements, and cost.

(continued on next page)



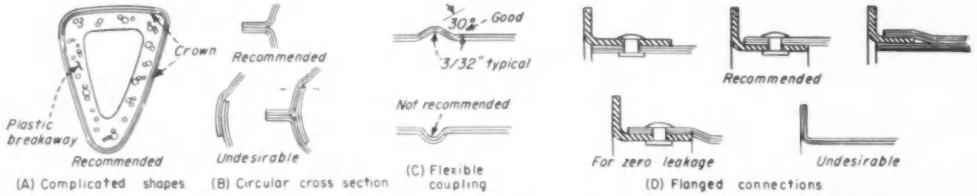
(A) Molded thickness (B) Local reinforcement

THICKNESS AND TOLERANCES (A) Total laminate thickness is the sum of the thicknesses of individual plies and are generally in the range of 0.020 to 0.125 inches. (B) Local reinforcement for stiffening or edge attachment can be provided by addition of extra laminations. Operational requirements usually govern thicknesses, but fabrication methods and abuse in the shop may make extra thickness necessary. (C) Thick edges on large molded honeycomb structures are difficult



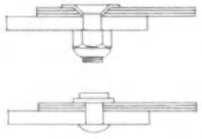
(A) Low density cores (B) Corrugations and bead (C) Undercuts

CORES, BEADS AND JOGGLES (A) Low density core materials can be incorporated for increased stiffness to weight ratio. Balsa wood is often used for complicated shapes when core faces are not parallel. Cover laminations must be extended to edge of part when matching die type molds are used but not when using vacuum bag techniques. (B) Corrugations and beads may be included for strength and/or directional stability. Common bead cross section is illustrated, although shape can be made as desired. (C) Undercuts should be avoided because they require collapsible molds or plaster breakaway molds.



(A) Complicated shapes (B) Circular cross section (C) Flexible coupling (D) Flanged connections

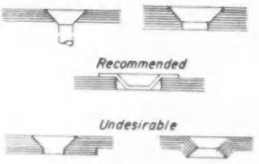
DUCTS (A) Complicated ducts or ducts produced in low quantity are fabricated in plaster breakaway molds. Flat sides necessitate auxiliary blocks or vacuum pressure to prevent loose wrinkled wraps in low pressure areas and tight starved wrap in high pressure area; crowning prevents these difficulties. Undercuts also require auxiliary pressure devices. (B) Ducts are designed for matching dies when production quantities exceed about 50 pieces and shapes are simple. External flanges are recommended. The construction, left, results in difficult secondary assembly, while that at right is used only when pressures exceed 5 psi, diameters are over 6 in. and zero leakage is required. From four to five laminations are necessary



(A) Washers

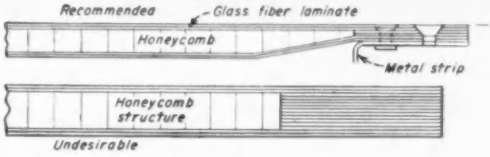
Rivet diameter	Thickness of laminate	Edge distance (min.)	Hole size
3/32	1/8 or less	9/32 (3D)	# 39 (0.099)
	over 1/8	1/4 (2-1/2D)	# 40 (0.098)
1/8	3/16 or less	3/8 (3D)	# 29 (0.136)
	over 3/16	5/16 (2-1/2D)	# 30 (0.128)
5/32	1/4 or less	15/32 (3D)	# 18 (0.169)
	over 1/4	13/32 (2-1/2D)	# 21 (0.159)

(B) Edge distances and hole sizes

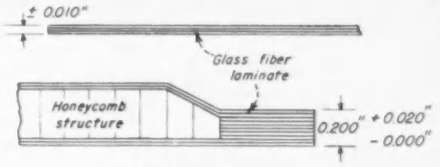


(C) Countersinking details

FASTENING AND JOINING (A) The use of washers with rivets normally is not necessary. However, the tendency of rivets to pull through thin laminates may be reduced by using a flat washer under the upset head in those cases where the upset head is on the plastic side. Washers should be used to reduce the possibility of cracking in applications where the minimum recommended edge distances (see table) cannot be met and the upset head is on the plastic side. Dimpled washers are useful for flush screw applications where the minimum recommended thickness for countersinking cannot be met. (B) The tendency for laminated parts to split or crack at the time of riveting is reduced considerably by maintaining these

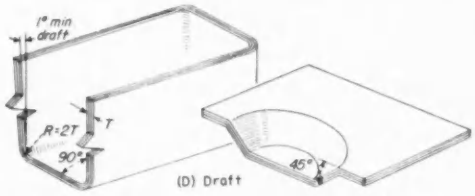


(C) Edge on large parts

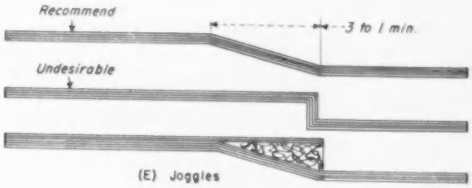


(D) Tolerances

to fabricate. Parts made on female molds by the vacuum technique should be limited to ¼ in. or less or governed by recommendations for countersinking. Metal strips or angles can be used for stiffness or bearing strength. (D) A tolerance of ±0.010 in. generally applies to molded honeycomb structures, but when a female mold with pressure or vacuum (*A* and *B* under fabrication) is used, the tolerance may be as much as 10 percent of total thickness for sections 3/16 in. or greater.

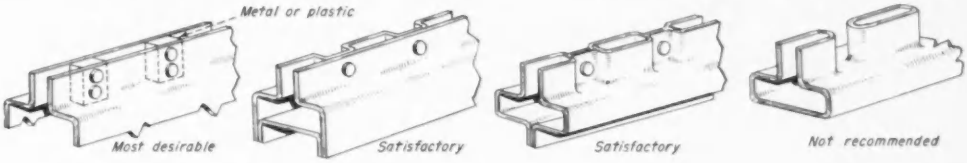


(D) Draft



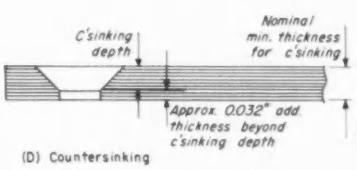
(E) Joggles

(D) Draft is required for deep parts having parallel sides: One degree minimum is recommended. Angles less than 90 deg on a part shaped as at the top are undesirable; for irregular cross sections, a 45 deg shape should be used. Outside radii should equal *2T*, and inside radii, at least the lamination thickness. Inside square corners require matching dies. Outer square corners can be obtained by using glass mat filler with a fabric face (methods *A*, *B*, and *G* under fabrication). (E) A gradual slope rather than a sharp step is recommended but a mat filler covered by one or two plies of fabric can be used.



(E) Irregular outlet

for zero leakage at 10 psi. (C) Flexible couplings should be used in place of flanged connections if possible. A bead having a small slope is better than one with a sharp radius. (D) Flanges may be metal or glass filler laminate. Construction at left is used only when zero leakage is necessary. Construction at right necessitates auxiliary device for pressure on flange when wrapping on breakaway is used—usually on small parts. Also complicates handling of breakaways and prevents increasing flange thickness. (E) For irregular outlets, a one piece design is difficult to fabricate, and requires a plaster breakaway mold. If similar halves with a metal or plastic space is impractical, place the split in one plane and join the halves.



(D) Countersinking

Minimum thicknesses for countersinking

Rivet size, in.	3/32		1/8		5/32	3/16						
Screw size		#4		#6			#8	#10	1/4"	5/16"	3/8"	7/16"
Min. nom. thick. for 100° c'sinking (in.)	.070	.080	.080	.090	.090	.100	.110	.125	.140	.190	.220	.225

minimum edge distances; these distances are recommended also for screws of equivalent size. To prevent breakout: (1) limit rivet diameter to 5/32 in. or less; (2) keep holes normal to the direction of lamination; (3) use rivet head on plastic side of joint so that upset is made against a hard material. (C) Flush attachments of laminated parts are made on matching die type molds (p 161). For increased thickness at rivet hole, either increased overall thickness or dimpled washers should be used. Adding laminations locally when using matching die type molds, or dimpling for flush rivets or screws, is generally undesirable. (D) Countersinking details, including the nominal thickness of laminations for various rivet and screw sizes.

Table I—Creep and Rupture Strength of Ti 150A Titanium Alloy[1]

Temp.	Stress to Produce Rupture 100 Hours	500 Hours	1000 Hours
600 F.	72,000 psi	71,000 psi	70,000 psi
750 F.	56,000 psi	47,000 psi	44,000 psi
900 F.	23,000 psi	15,000 psi	12,500 psi

Stress to Produce 0.5 Percent Creep in 1000 Hours.

600 F. 35,000 psi 750 F. 25,000 psi 900 F. 5,000 psi

[1] ½ in. dia. bar

Fig. 1—Experimental titanium parts for reciprocating engine after failure under simulated operating conditions. Both parts were forged from ferro-chrome alloys, the piston of material having a lower alloy content.

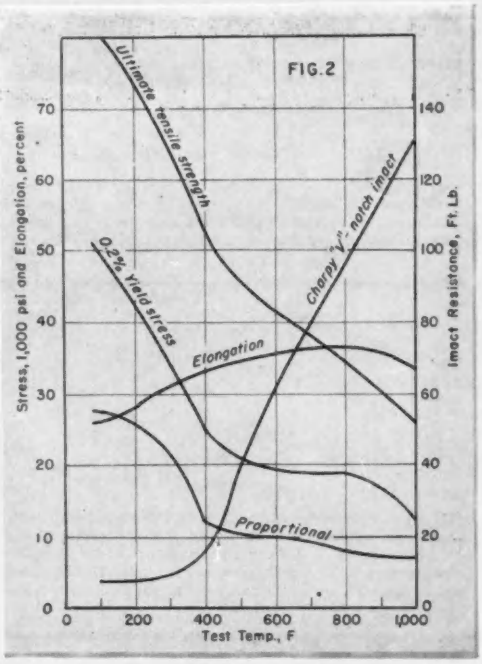


Fig. 2—Short time tensile properties of hot rolled and annealed ½ in. bars of commercially pure titanium. See text for sheet properties.

Fig. 3—Short time tensile properties of hot rolled and annealed ½ in. bars of Titanium Metals Corp. Ti 150A alloy.

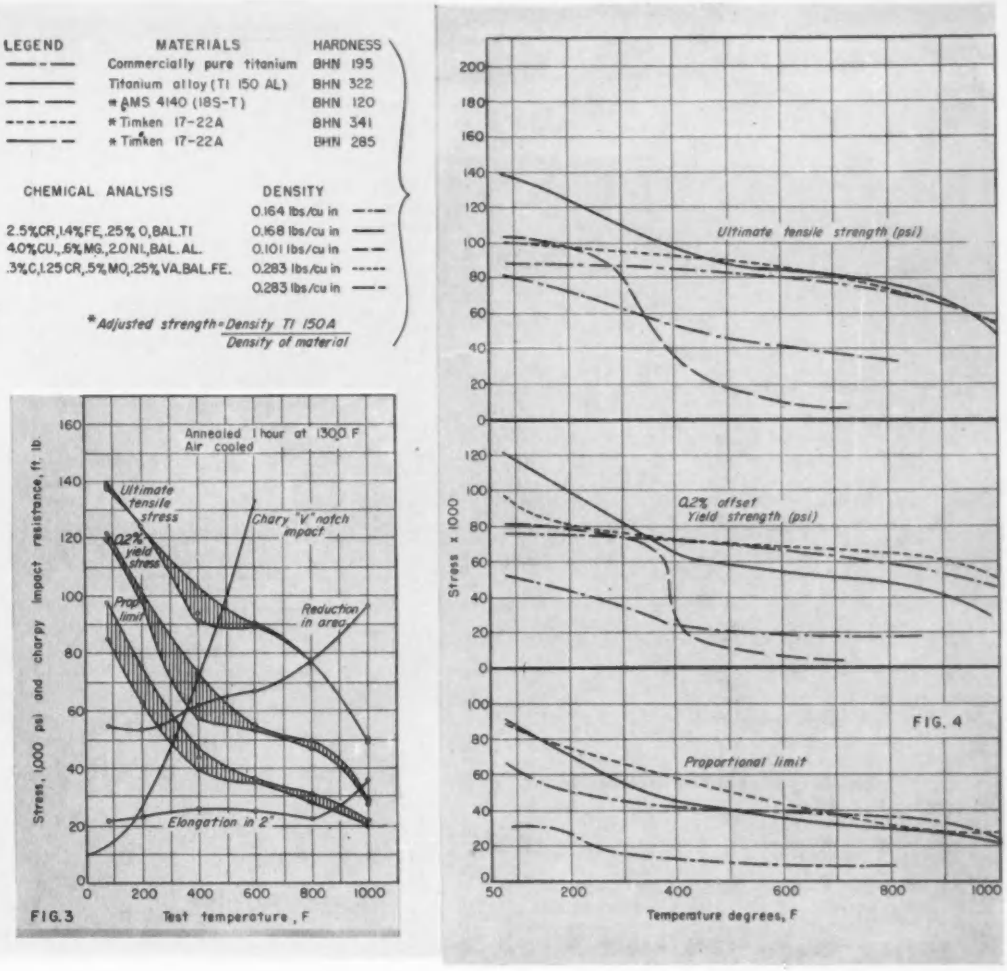
Fig. 4—Short time tensile properties adjusted for density: pure titanium, a titanium alloy, an aluminum alloy, and alloy steel.

A Realistic Approach to the

IT IS FORTUNATE that up to now the principal applications of titanium and titanium alloys have been in statically, rather than dynamically loaded structures—fortunate because many of those applications may well have been made without regard to some of the basic properties of the material. As a matter of fact, information that normally would be considered essential for the intelligent application of other materials has either been lacking or else has been only partially available in the case of titanium.

For example, temperature-tensile data on commercial alloys have resulted in information that is often applied indiscriminately to forgings. If a forging is small, perhaps it receives an amount of hot work equal to that put into a rod in the rolling mill, but certainly such is not the case with a large forging. Furthermore, heat-treatment, subsequent machining, or forming operations must affect mechanical properties. Yet the design of parts has, for the most part, been based on the property data of hot rolled bar stock as received from the rolling mill.

Another and perhaps one of the most significant facts about high strength titanium alloys is just now being revealed: some of these alloys seem to be sensitive to surface condition and finish. As a result, the fatigue strength of notched test specimens may



Use of Titanium

HERMAN H. HANINK
Manager
Materials and Processes Research Division
Wright Aeronautical Corporation

be as low as 3 percent of the ultimate strength at 100,000,000 stress cycles, as compared to about 15 percent for alloy steels tested with the same notch. And as might be expected, the use of conventional shot peening methods to improve this situation may do more harm than good.

In short, it is relatively easy to determine where titanium could be used, based on its properties of light weight, high strength, and excellent resistance to corrosion. But it is quite another matter to determine where it should be used, particularly for structures under dynamic loads.

Mechanical Properties of Titanium Alloys

In an attempt to define these parameters of use for titanium and titanium alloys, a series of tests were undertaken to determine:

1. The mechanical properties of certain hot-rolled and annealed alloys.
2. The effect of heat-treatment on these properties.
3. The difference in properties between forged parts and test bar specimens.
4. The behavior of machined titanium components subject to dynamic loading under simulated engine operating conditions.

All tests completed to date were conducted with Titanium Metals Corp-

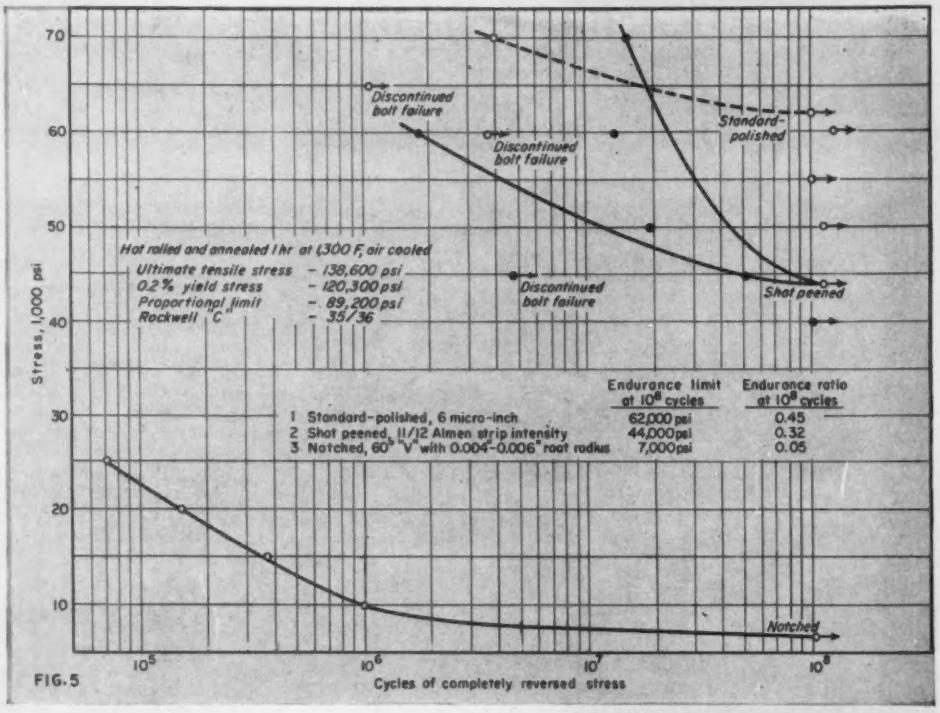


Fig. 5—Fatigue strength of ¾ in. bars of Ti 150A. Note the low endurance ratio obtained with a notched specimen, and the adverse effect of shot peening on fatigue strength.

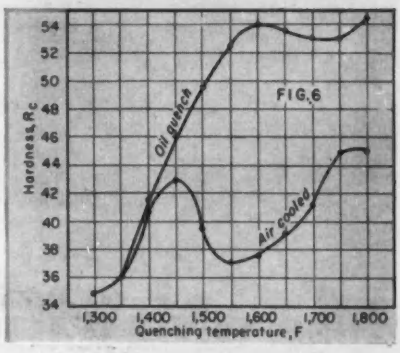


Fig. 6—Effect of quenching on the hardness of Ti 150A. Specimens were held for 1 hr. in the furnace. Point of hardness drop for the air cooled specimen corresponds to a change in grain structure, as does the point of maximum hardness.

Fig. 7—Effect of tempering temperature on hardness of Ti 150A. The upswing in hardness above 1,200 F. for the lower solution treatments indicates that this temperature may be best for maximum stability. This was later substantiated.

oration materials primarily because those were one of the first series commercially available when the program was started. Specifically, the program was limited to Ti 75A, commercially pure titanium, and Ti 150A and 170A. These latter are alloys obtained by a ferro-chrome addition, the alloy number being an index of either yield or ultimate strength at room temperature.

The mechanical properties of commercially pure titanium in hot-rolled bar form are shown in Fig. 2. In hot-rolled and annealed sheet form, the typical room temperature properties of $\frac{1}{16}$ in. sheet tested by Wright are as follows: ultimate strength, 99,000 psi; yield strength at 0.2 percent offset, 86,700 psi; proportional limit, 67,000 psi; and elongation at 2 in., 22 percent. Since these values for tensile strength can be increased or even doubled by the addition of small amounts of alloying elements, commercially pure metal has been used only when high strength is of no special interest or when formability and weldability is important, as in sheet metal applications.

Alloy Ti 150A is a commercial material having a nominal ultimate strength of 150,000 psi. Alloy Ti 170A, which simply has a higher ferro-chrome addi-

tion, has an ultimate strength on the order of 170,000 psi; it was developed for such parts as reciprocating engine connecting rods, for which a high strength material comparable with alloy steel is required. In this respect, Ti 170A gives a surprising benefit in ductility for the same yield and ultimate strength, as compared with an SAE X-4340 steel connecting rod.

The short-time tensile properties of alloy Ti 150A are shown in Fig. 3. These properties are for hot rolled and annealed bar stock as received from the mill, including an annealing treatment at 1,300 F. for 1 hour. After adjustment on the basis of density, Ti 150A is seen from Fig. 4 to have an advantage in tensile strength over a typical low alloy high temperature steel only under about 500 F., while it is superior to high temperature, high strength aluminum alloys at all test temperatures. Impact resistance is fair and improves with increasing temperatures. As a matter of fact, 600 F. was the highest test temperature at which specimens could be broken.

Creep-rupture tests also were made on titanium Ti 150A, Table I. One of the most interesting characteristics of titanium in creep is that it remains in the first stage for an abnormally long time. A time of at least 1,000 hrs is required to insure the beginning of second stage creep.

The major limitation of Ti 150A shows up when it is subjected to rotating beam fatigue tests, Fig. 5. As shown in the upper curve, the fatigue strength at 10^8 cycles for a ground and polished specimen was approximately 62,000 psi, giving an endurance ratio of 0.45. Steels have an endurance ratio of between 0.45 and 0.55.

Shot peening a specimen to a steel Almen strip intensity of 11 to 12 resulted in a rapid drop-off in fatigue strength. While this is the standard treatment for improving the fatigue strength of steel articulating rods of equal hardness, it obviously is too severe for titanium.

But as subsequent tests showed, conventional shot peening decreases fatigue strength regardless of intensity. A clue as to the reason is indicated in the fatigue curve for a notched specimen: strength drops off to a value less than 7,000 psi at 10^8 cycles, indicating an endurance ratio on the order of 0.05.

Because of this large decrease in fatigue strength over that obtained with a polished bar, several specimens were sectioned to determine if surface metal disturbance at the root of the notch was the cause. Since the practice at Wright Aeronautical is to crush grind the notch, which is 0.032 in. deep and has a 60 deg angle and an 0.005 in. root radius, this was a logical possibility. However, so far as could be seen, the metal was normal.

As a further check, several finished specimens were stress relieved for 6 hr in helium at 1,300 F. Fatigue strength increased to 10,000 psi—still not too good but certainly an improvement—perhaps because annealing reduced stresses caused by the grinding operation, or re-annealed a surface layer hardened by grinding heat.

Other investigators have obtained more optimistic results with bars having machined notches. The values shown in Fig. 5 were obtained under the least favorable conditions. Perhaps because of the low thermal conductivity of titanium, the surface temperature during crush grinding is sufficiently high to cause micro-cracks when the material is cooled. Certainly it is a fact that relatively fast quenching of titanium from high temperatures will produce minute cracks in the surface due to residual stresses.

The significance of this and the previous data obtained from fatigue specimens is that it places titanium in a category with magnesium insofar as notch sensitivity is concerned. It also shows titanium to be extremely sensitive to surface conditions. This is one reason why all parts designed for engine use at Wright Aeronautical are now given a stress relieving treatment after completion of all machining.

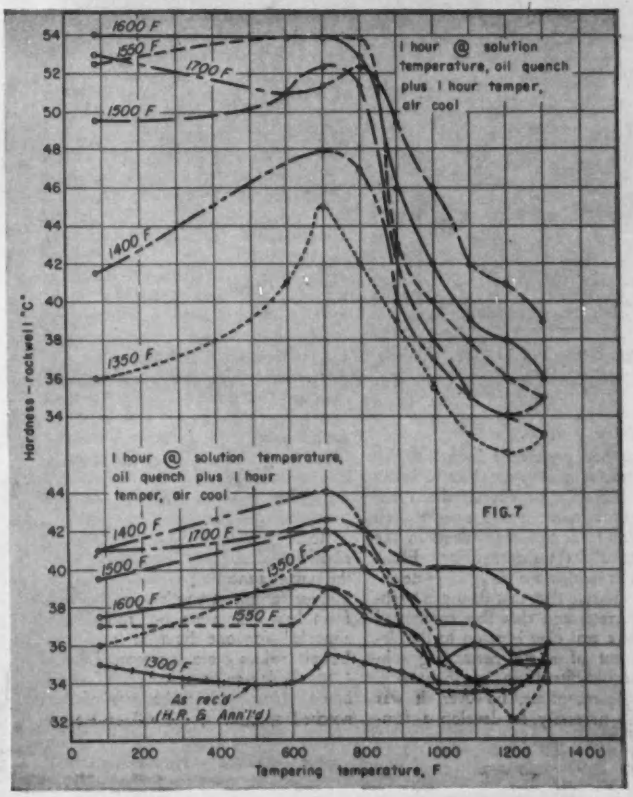


FIG. 7

Effect of Heat Treatment on Properties

An investigation of heat-treatment of Ti 150A was initiated to determine its general reactions and to ascertain whether a heat-treatment existed that might be more favorable to the alloy from the standpoint of notch sensitivity.

A series of hot rolled unannealed test specimens were heated to from 1,100 F to 1,800 F, and quenched in air, oil, and the furnace. They were then tempered at various increments up to the point at which rehardening occurred, and sectioned, polished, and etched to obtain a comparison of microstructures. At the same time, checks were made on bar hardness at these quenching temperatures.

As can be seen from Fig. 6, the

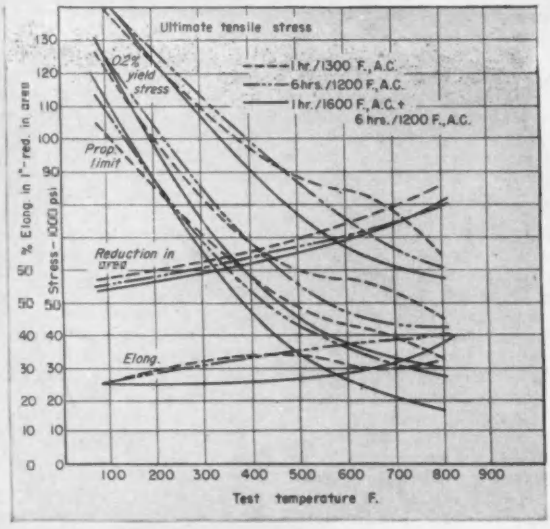


Fig. 8—Short time tensile properties of Ti 150A after three different heat-treatments. The hump in the curves for material heat-treated at 1,300 F. for one hour was taken to indicate an incompletely annealed structure.

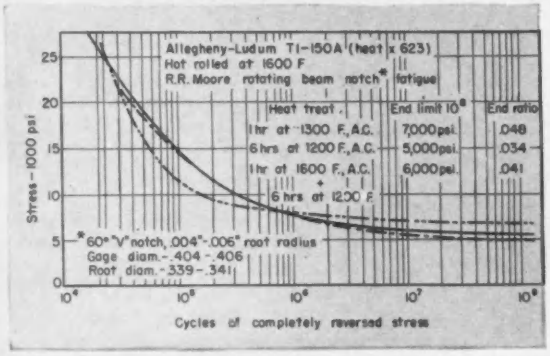

Allegheny-Ludum Ti-150A (heat x 623)
Hot rolled at 1600 F
R.R. Moore rotating beam notch* fatigue
Heat treat.
End limit 10^8
End ratio
1 hr at 1300 F., A.C. 7,000 psi .048
6 hrs at 1200 F., A.C. 5,000 psi .034
1 hr at 1600 F., A.C. + 6 hrs at 1200 F. 6,000 psi .041
*60° "V" notch, .004"-.006" root radius
Gage diam. - .404 - .406
Root diam. - .339 - .341
Stress - 1000 psi
Cycles of completely reversed stress

Fig. 9—How heat treatment affects the fatigue strength of Ti 150A. The solid curve is for fully solution treated and annealed specimens.

hardness of the air-cooled specimens dropped off above 1,450 F. and then rose to a peak at 1,750 F; in the case of the oil-quenched test bars, this variation did not occur. These points of temperature corresponded to a change in grain structure—between 1,400 and 1,500 F. being the lowest temperatures at which definite grain formation could be discerned, and above 1,600 F., the region of rapid grain growth.

These and other results seem to indicate that these alloys cannot be fully represented by a simple two phase system, as had previously been thought. The results that were obtained can more plausibly be explained on the basis of a three phase system with compound formation involved in the beta to alpha transformation. Phase diagrams, which are now being developed, indicate that this theory is probably correct, and that this compound may be a real clue later on to the development of alloys permitting substantial benefits from heat-treatment.

In the meantime, however, it was thought necessary to develop a tempering treatment that would result in a fully stress relieved condition. Using the points on the curves in Fig. 6 as the initial starting points, a series of curves, Fig. 7, were plotted of hardness versus tempering temperature. As the tempering temperature was increased, a peak in hardness occurred in all the curves at around 800 F.; this was interpreted as indication of third phase precipitation. Beyond this peak, hardness dropped up to 1,200 F., and then leveled off and began to increase for solution temperatures under 1,500 F.

The significance of this is that it shows that rehardening starts at 1,200 F. for Ti 150A air-cooled from 1,300 F. Since this is the mill treatment usually given hot rolled titanium alloy bar, the curves pointed to the fact that annealing should be carried out not only for a longer period of time but also at a lower temperature.

Accordingly, a 6-hr treatment at 1,200 F. was selected as the probable one that would give the full anneal without the possibility of re-solution and age hardening effects. The comparison of actual properties, Fig. 8, substantiates this conclusion.

On this chart are shown tensile-temperature properties for Ti 150A specimens given three different heat-treatments. The properties of the hot-rolled and annealed bars (dash lines) follow the usual pattern except for a hump that occurs in the curves for tensile strength, yield strength and proportional limit beginning at about 500 F. At the same time the ductility, as measured by elongation in 2 in., drops. In the low temperature range, the properties are so close that it is impossible to say that one annealing treatment is better than the other. However, the fact that the curve for the specimen heat-treated for one hour at 1,300 F. crosses over the curve for the specimen heat-treated for 6 hr at 1,200 F. indicates that some precapitation hardening had occurred and the material was not fully stable.

The solid lines, which represent the material heat-treated for one hour at 1,600 F., cooled in air and annealed for six hr at 1,200 F., show somewhat lower properties. This is apparently due to a change in grain structure that occurs above about 1,500 F., as was previously discussed.

Rotating beam fatigue tests, Fig. 9, also were made on specimens given the same annealing treatments. The highest fatigue strength was obtained from bars that were hot rolled and annealed for one hour at 1,300 F. Lowest values were represented by a 1,200 F. degree heat-treatment for six hours. However, in the case of the notched specimens, the values are so

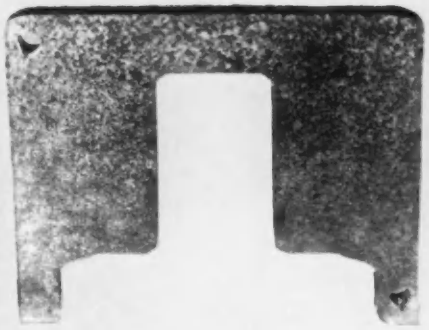


Fig. 10—Variation in grain size through cross section of aircraft engine piston. Larger grains obviously indicate a much smaller amount of hot work.

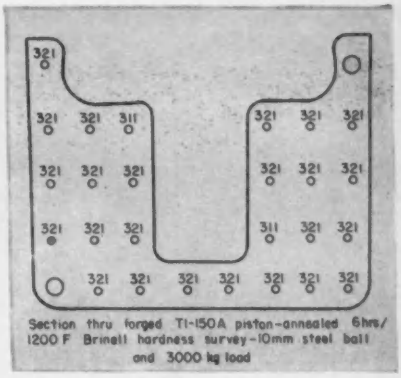


Fig. 11—The hardness through the cross-section of the piston was uniform in spite of the variation in hot work and difference in grain size.

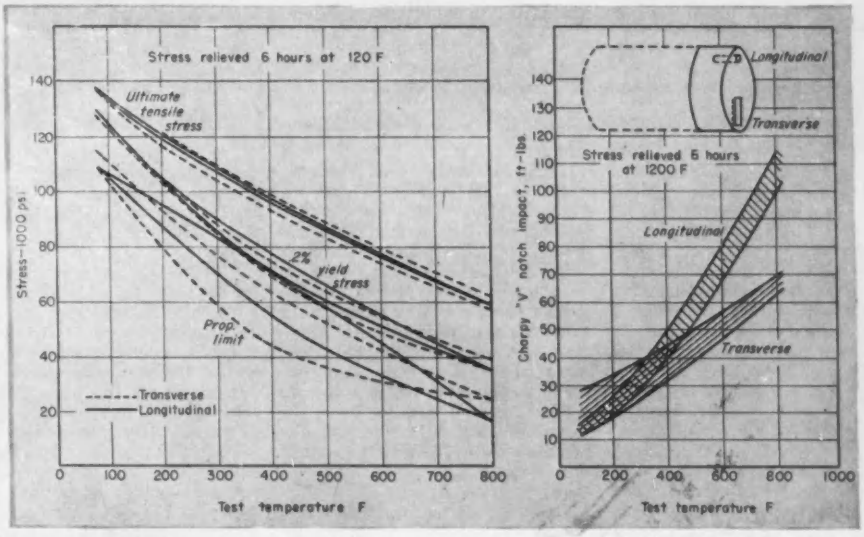


Fig. 12—Properties of transverse and longitudinal test specimens from the machined billet for the piston forging. Scatter of the values observed during impact tests, right, decreased with increasing test temperatures.

close as to be within the test limits, and in no case did the endurance ratio exceed 7 percent.

Also, this data can be interpreted only on a trend basis; there is no certainty that the values are absolute since the bars from which these specimens were taken showed a rather large micro-segregation through the cross section. The tensile results should be fairly valid, however, since the variations in structure should average out.

To actually compare the properties of these test specimens with parts that might be used for engines, two programs were undertaken. One was on a titanium alloy piston forged of Ti 150A and the other on an articulating connecting rod, which also was forged of Ti 170A. Data obtained from these experimental parts included basic information on forgability and also on mechanical properties.

Piston forgings were made, stress relieved 6 hr at 1,200 F, and single cylinder tested. The remaining metal from the original 6 in. dia. machined billet used for these forgings was supplied for checking and comparing the mechanical properties with those of the actual forged part.

The variation in grain size caused by different amounts of work and recrystallization is apparent in Fig. 10. The large grain areas, center of dome and bottom of skirt, are due to die lock. Although this resulted in relatively little work being imparted to these areas, hardness was uniform, Fig. 11, in spite of this.

A comparison of tensile properties of specimens taken longitudinally and

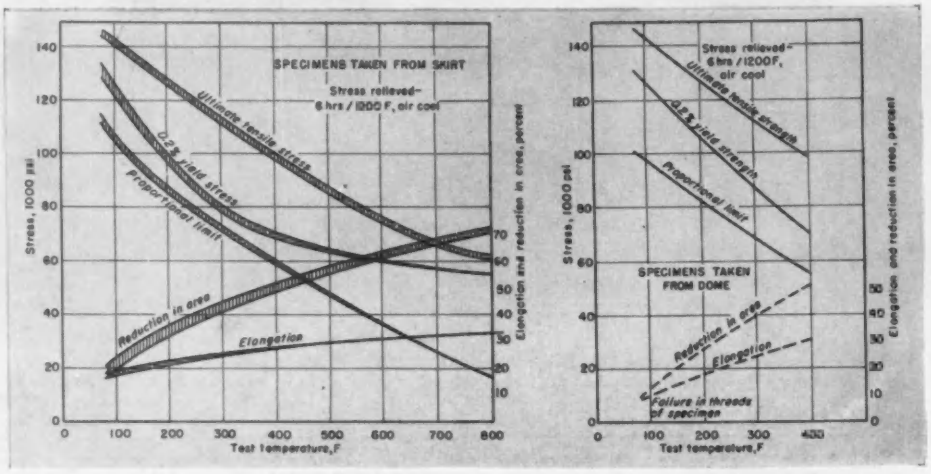


Fig. 13—Properties of test specimens taken from skirt and dome of piston forging. The correlation with the properties of the billet is good, although dome specimens were of sub-standard length and failed in the threads.

transversely from the 6 in. dia. billet are given in Fig. 12. Also included in this curve are impact data versus temperature for longitudinal and transverse specimens. The scatter, as indicated by the widths of the data bands; is greater for transverse specimens, but decreased with higher temperature.

A comparison of the short-time tensile properties versus temperature is shown in Fig. 13 for specimens taken from the skirt and dome of the piston forging, which was stress-relieved 6 hr at 1,200 F. The test results compare favorably with each other and reported values for alloy Ti 150A. The low room temperature ductility figures for the dome specimens were caused by the sub-standard lengths of specimens and insufficient number of threads, which caused some failure in the threads.

These results indicate that there is some, although not appreciable, difference in properties between specimens taken from the forging, the billet, and test bars, (previous data.) In no instance would a complete redesign be required to obtain satisfactory tensile properties.

Another forging was machined and stress-relieved 6 hr at 1,200 F., then covered with a graphite coating prior to subjecting it to single cylinder test duplicating engine conditions. As was expected, the piston exhibited poor running characteristics. It scored, galled, and eventually cracked, as the heading illustration shows. However, this investigation was undertaken primarily to obtain basic properties, secondarily to determine running characteristics. Clearance for the titanium piston was the same as for aluminum, even though it was known that titanium would run hotter because of its poorer thermal conductivity. In short, there was not a sufficient amount of investigation put into the design of the piston to warrant the statement that titanium was unsatisfactory.

Another forging investigation was undertaken with a connecting rod, this time using alloy Ti 170A. As previously mentioned, this alloy has a higher ferro-chrome content than alloy 150A and theoretically has an ultimate tensile strength of 170,000 psi. Short time tensile tests on this material, however, did not result in quite such good properties, as can be seen by Fig. 14. The curves for ultimate strength started at 160,000 psi at room temperature and dropped to about 40,000 psi at 1,000 F. While yield strength initially was close to the ultimate strength, the drop in properties over the testing temperature range is quite similar to that obtained with Ti 150A. Above 600 to 800 F., there is not much difference in these materials.

Fatigue strength was obtained and plotted as shown Fig. 15. Again this data was on hot-rolled bar stock, although the bar stock was taken from the same heat subsequently used for the connecting rod forging. The fatigue strength of a polished specimen of this material was appreciably higher than that of alloy 150A. It averaged about 88,000 psi at 100,000,000 stress cycles. What was somewhat disconcerting however, was its low strength with a notch; as can be seen in the curve, the fatigue strength of the notched specimen was about 5,000 psi—no better than the alloy with a lower ferro-chrome content. This was unfortunate because, as can be seen on the short-time tensile tests, the elongation of this material was extremely good in relation to its strength; and as compared to steel at the same strength level.

Machined and stress-relieved forgings were subjected to simulated engine conditions in a push-pull fatigue machine. Failure occurred in one case after 14,000,000 cycles at 100 percent of take-off load in addition to 3,000,000 cycles at the equivalent of 150 percent overload, relative to engine take-off conditions. Steel rods will usually withstand 100 percent overload in this type of test without failure. The push-pull machine subjects the rod to some twist, but nobody knows how close it comes to simulating the loading of a rod in an engine. In all cases, failure seemed to start around the pressed-in bushing—originating in scratches produced in installing the bushing. Actually these tests are not conclusive in a sense; the only

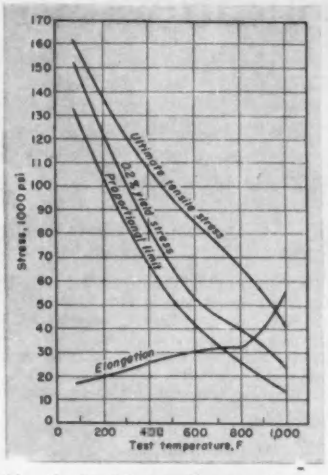


Fig. 14—Short time tensile properties of annealed ¼ in. bars of Ti 170A alloy.

way to determine whether the rod is satisfactory is to run it to destruction in a single cylinder engine test or in a full scale engine.

Despite these failures this alloy should be suited for many applications. For statically loaded structures such as gas turbine compressor rotor disks, this might be an excellent material. But for dynamically loaded parts where notch fatigue strength is important, the alloy is not particularly better than one having a lower ultimate tensile strength.

More Data Needed

These investigations have definitely shown titanium to offer a wide range of useful physical properties when properly alloyed. They have also shown that heat-treatment can materially alter these properties.

While properly produced forgings appear to cause no appreciable change in properties from the original billet or bar stock, subsequent machining operations applied to such forgings may have a major effect on the characteristics of the finished parts due to the surface disturbances caused by such machining operations.

Possibly the most significant information obtained from these tests is the data related to notch sensitivity. The notch sensitivity indicated for the alloys tested is probably closely related to the adverse effect of machining operations as noted above. There is of course no certainty that all titanium alloys are notch senstitive as compared to alloy steel, although data from preliminary tests would so indicate.

On dynamically loaded parts which are reciprocating or rotating at high speed, the engineer can often obtain the maximum advantage from the high strength to ratio of titanium. Here a saving in weight is obtained not only in the dead weight of the parts, but also from reduced dynamic loads and resulting size of supporting members. Thus, the weight saving is multiplied beyond the approximate 40 percent that might be expected from the direct substitution of titanium for steel. However, because of concern over the apparent notch sensitivity of the titanium alloys, moving parts for which the use of titanium gives the biggest advantage may also be the source of the greatest difficulties in application. If it becomes necessary to compensate for notch sensitivity in the design of parts to replace steel, then the designer may have to be content with something less than the full saving in weight obtained from the use of titanium for statistically loaded structures.

This is probably an overly pessimistic viewpoint. Magnesium is a relatively notch sensitive material but engineers have been obviously successful in overcoming this difficulty in its application. However, the application of magnesium has taken place quite slowly —over a period of ten or fifteen years —and with a corresponding growth in the appreciation of the design factors involved. This same process should and must be followed in the application of titanium, or it is possible that initial failures from its improper use may hinder the rapid utilization which seems merited by its uniquely desirable combination of properties.

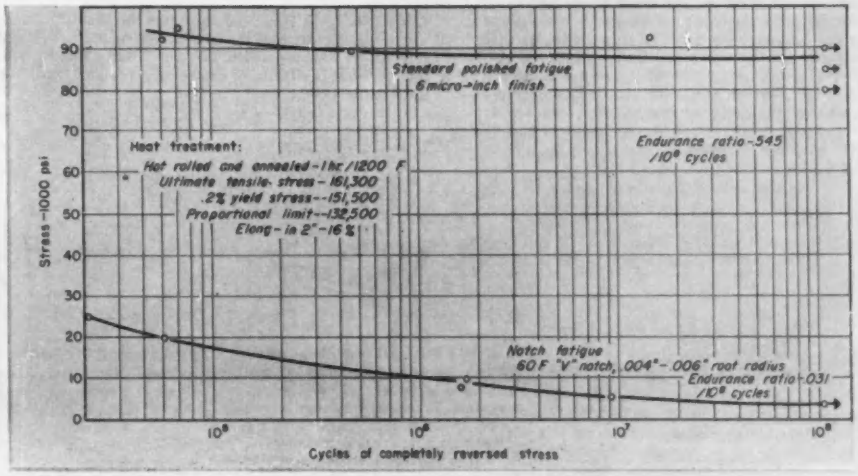


Fig. 15—Fatigue strength of ¼ in. bars of Ti 170A. Notch endurance limit is no higher than that of Ti 150A.

Toggle Linkage Applications in

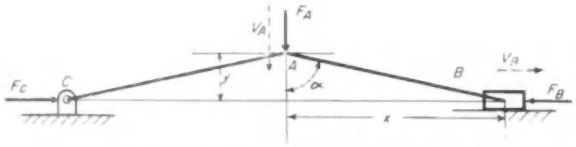


Fig 1 Mechanical advantage = $\frac{F_B}{F_A} = \frac{l}{2}\frac{x}{y} = \frac{l}{2}\,\text{Tan}\,\alpha = \frac{V_A}{V_B}$

MANY MECHANICAL LINKAGES are based on the simple toggle which consists of two links that tend to line-up in a straight line at one point in their motion. The mechanical advantage is the velocity ratio of the input point *A* to the output point *B*: or V_A/V_B. As the angle α approaches 90 deg, the links come into toggle and the mechanical advantage and velocity ratio both approach infinity. However, frictional effects reduce the forces to much less than infinity although still quite high.

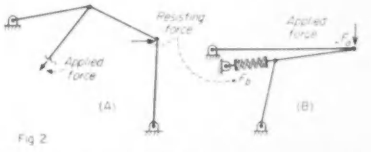


Fig 2

FORCES CAN BE APPLIED through other links, and need not be perpendicular to each other. **(A)** One toggle link can be attached to another link rather than to a fixed point or slider. **(B)** Two toggle links can come into toggle by lining up on top of each other rather than as an extension of each other. Resisting force can be a spring force.

HIGH MECHANICAL ADVANTAGE

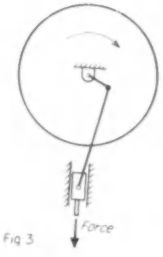
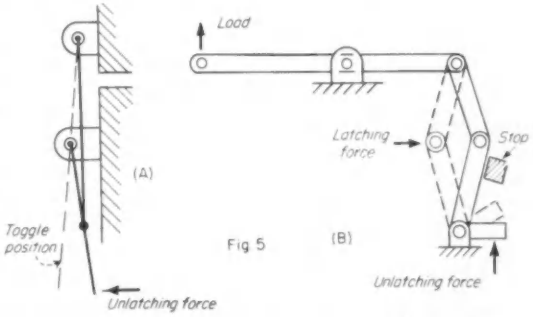


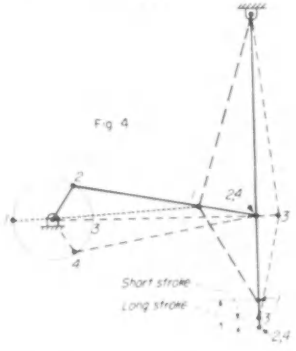
Fig 3

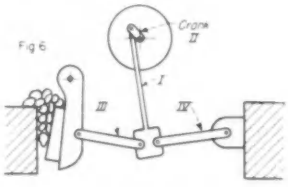
IN PUNCH PRESSES, large forces are needed at the lower end of the work-stroke, however little force is required during the remainder. Crank and connecting rod come into toggle at the lower end of the punch stroke, giving a high mechanical advantage at exactly the time it is most needed.



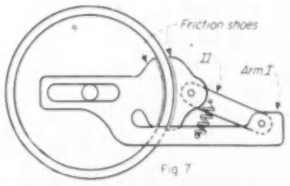
LOCKING LATCHES produce a high mechanical advantage when in the toggle portion of the stroke. **(A)** Simple latch exerts a large force in the locked position. **(B)** For positive locking, closed position of latch is slightly beyond toggle position. Small unlatching force opens linkage.

COLD-HEADING RIVET MACHINE is designed to give each rivet two successive blows. Following the first blow (point 2) the hammer moves upward a short distance (to point 3), to provide clearance for moving the workpiece. Following the second blow (at point 4), the hammer then moves upward a longer distance (to point 1). Both strokes are produced by one revolution of the crank and at the lowest point of each stroke (points 2 and 4) the links are in toggle.





STONE CRUSHER uses two toggle linkages in series to obtain a high mechanical advantage. When the vertical link I reaches the top of its stroke, it comes into toggle with the driving crank II; at the same time, link III comes into toggle with link IV. This multiplication results in a very large crushing force.



FRICTION RATCHET is mounted on a wheel; light spring keeps friction shoes in contact with the flange. This device permits clockwise motion of the arm I. However, reverse rotation causes friction to force link II into toggle with the shoes which greatly increases the locking pressure.

Different Mechanisms

THOMAS P. GOODMAN
Westinghouse Electric Corporation

HIGH VELOCITY RATIO

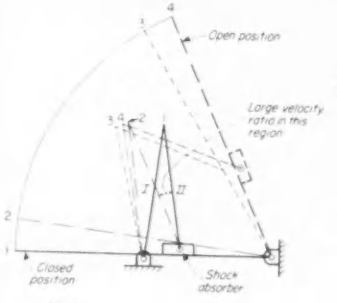


Fig. 8

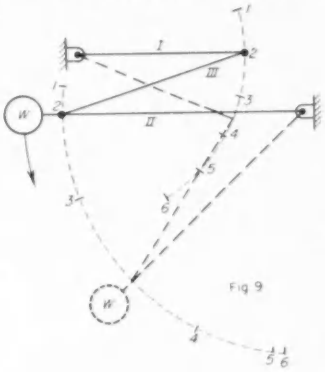


Fig. 9

DOOR CHECK LINKAGE gives a high velocity ratio at one point in the stroke. As the door swings closed, connecting link I comes into toggle with the shock absorber arm II, giving it a large angular velocity. Thus, the shock absorber is more effective retarding motion near the closed position.

IMPACT REDUCER used on some large circuit breakers. Crank I rotates at constant velocity while lower crank moves slowly at the beginning and end of the stroke. It moves rapidly at the mid stroke when arm II and link III are in toggle. Falling weight absorbs energy and returns it to the system when it slows down.

VARIABLE MECHANICAL ADVANTAGE

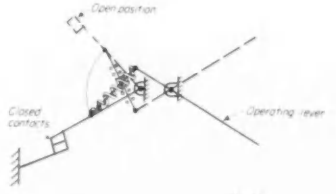


Fig. 10

TOASTER SWITCH uses an increasing mechanical advantage to aid in compressing a spring. In the closed position, spring holds contacts closed and the operating lever in the down position. As the lever is moved upward, the spring is compressed and comes into toggle with both the contact arm and the lever. Little effort is required to move the links through the toggle position; beyond this point, the spring snaps the contacts closed.

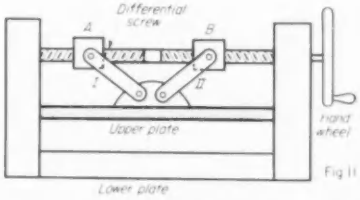
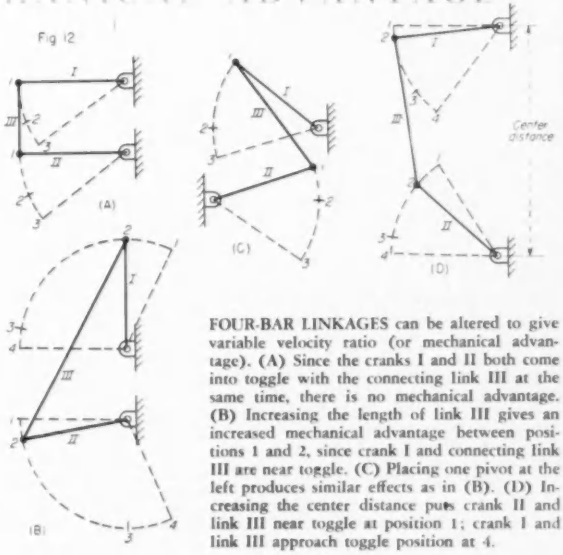


Fig. 11

TOGGLE PRESS has an increasing mechanical advantage to counteract the resistance of the material being compressed. Rotating handwheel with differential screw moves nuts *A* and *B* together and links I and II are brought into toggle.

Fig. 12



FOUR-BAR LINKAGES can be altered to give variable velocity ratio (or mechanical advantage). (A) Since the cranks I and II both come into toggle with the connecting link III at the same time, there is no mechanical advantage. (B) Increasing the length of link III gives an increased mechanical advantage between positions 1 and 2, since crank I and connecting link III are near toggle. (C) Placing one pivot at the left produces similar effects as in (B). (D) Increasing the center distance puts crank II and link III near toggle at position 1; crank I and link III approach toggle position at 4.

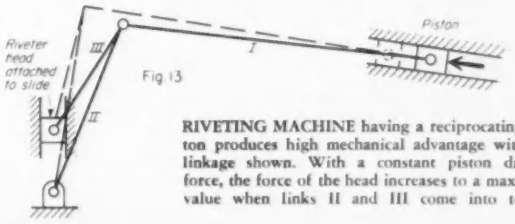


Fig. 13

RIVETING MACHINE having a reciprocating piston produces high mechanical advantage with the linkage shown. With a constant piston driving force, the force of the head increases to a maximum value when links II and III come into toggle.

Friction Wheel Drives Designed for Maximum Torque

Analysis of forces present in a friction wheel drive. Development of a design for drives that can be utilized to protect machines from excessive load torques.

RUDOLF KROENER

DURING THE POST WAR YEARS, as a consequence of the general scarcity of leather, rubber, and metals, in Germany efforts were made to replace belt drives and gear drives with friction wheel drives. The satisfactory results obtained are ascribed to:

1. Ability to manufacture a facing material having a high coefficient of friction. Cellulose types of materials have been developed possessing coefficients of friction ranging up to 0.5. When compared with materials having friction coefficients ranging from 0.15 to 0.2, the new materials offer an opportunity to reduce bearing pressures 60 to 70 percent.

2. Development of designs in which the contact or normal force between the friction wheels is varied automatically with changes in load torque of the driven machine. These designs make it possible to apply friction wheel drives to serve as disconnect clutches for limiting the transmission of torque before it becomes excessive.

When the faces of two friction wheels are pressed together, and where

μ = coefficient of friction of the materials in contact
P = radial force pressing the wheels together, lb
T = force transmitted tangentially to the wheels at their point of contact without slip, lb
r = radius of driving wheel, in.
n = speed of driving wheel, rpm
H = horsepower transmitted by the friction wheel drive

$$T = \mu P \quad (1)$$

$$H = \frac{r\,n\,T}{63{,}025} \quad (2)$$

Since the radial force P is equal and opposite to the force exerted by the wheels on their supporting bearings, it is evident that for constant values of T the bearing pressures increase as the coefficient of friction decreases. Low coefficients of friction, therefore, are conducive to resultant power loss and bearing wear.

In a friction wheel drive where the wheel centers are adjusted and fixed to obtain a radial force sufficient to transmit a desired torque, the bearing pressure remains at a constant value regardless of variations in the transmitted torque. When the load torque varies to a large extent, such an arrangement compares unfavorably with gear drives and belt drives, since in such drives the bearing pressures vary with the torque transmitted.

This disadvantage is overcome in types of friction drives in which the driving wheel is mounted on a swinging center.

The swing drive shown in Fig. 1 is designed to change the radial pressure P simultaneously and automatically with variations in load torque. In this arrangement the motor is fastened to a sub-base. The sub-base is free to swing on an axle at the left side. The opposite side of the base is supported by a spring. The driving friction wheel is pushed upward by the spring to maintain contact with the driven wheel. The driven wheel is mounted on a non-adjustable center.

When the torque load on the driven

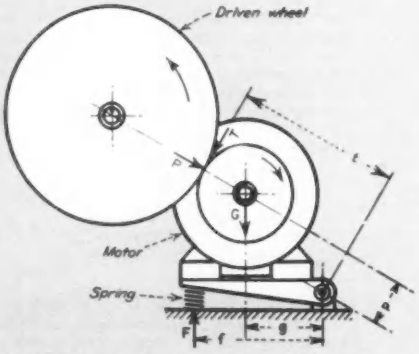


Fig. 1—Friction wheel drive in which swing base is supported by a spring and axle.

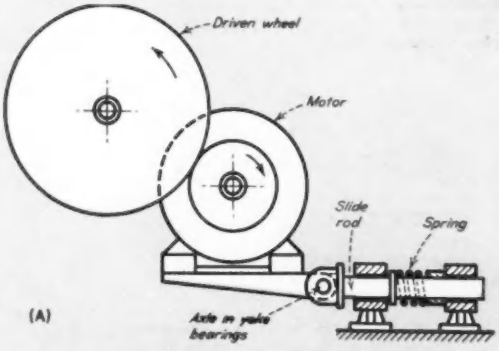


Fig. 2—(A) General arrangement of a maximum torque friction wheel drive with horizon-

wheel changes for any reason, the state of equilibrium is disturbed. The effect of an increase in torque load, until slipping occurs, is to cause the driving wheel to roll back or down on the driven wheel thus further compressing the spring. The spring force is thus increased, which results in an increased radial force P and an increase in the transmitted torque. Where

F = spring force, lb
f = horizontal distance from center of axle to line of spring force, in.
p = perpendicular distance from line of wheel centers to center of axle, in.
G = resultant of motor weight, driving wheel weight, and subbase weight, referred to axis of the motor, lb
g = horizontal distance from center of axle to vertical line passing through axis of motor, in.
t = perpendicular distance from tangent through point of contact of wheel faces to center of axle, in.

then to satisfy conditions of equilibrium

$$Gg - Ff - Pp + Tt = 0 \qquad (3)$$

and the spring force F is found by substituting in Eq (3) the value of P as given by Eq (1), or

$$F = \frac{Gg + T[t - (p/\mu)]}{f} \qquad (4)$$

In the design shown in Fig. 1, the extent to which the radial pressure P may build up, until slipping occurs, in response to increasing load torque is not limited. Excessive load torques may damage the friction facings, the driven machine, or the motor.

Any of many safety devices such as slip clutches, shear pins or keys, and breaking bolts, of course, can be used to protect the driven machine from excessive overloads. Fuses, overload relays, and thermal cut out devices can also be installed to protect the motor. Such protective devices are not necessary, however, when the friction wheel drive is designed to perform as a maximum torque clutch in which contact at the wheel faces ceases when a predetermined value of load torque is exceeded.

In the friction wheel drive shown in Fig. 2 (A), the drive motor M is fastened to a swing plate, one side of which is supported on an axle. This axle is free to turn in yoke bearings on the ends of rods that are free to slide in fixed bearings. The spring F is compressed between a shoulder and a spacer on each slide rod.

In this arrangement, an increase in load torque on the driven wheel causes the tangential force T to increase, which in turn causes the driving wheel to ride at a lower position on the face of the driven wheel.

As the driving wheel drops to a lower position, the cosine of the angle included between the line of centers of the axle and motor and the horizontal centerline of the slide rods increases, thus compressing the spring F and increasing the contact force P. With an increasing load torque, the driving wheel will finally fall away from the driven wheel.

At the instant of last contact of the two wheels, the spring has its maximum compression. The maximum torque that the arrangement shown in Fig. 2 (A) can transmit, therefore, depends upon the spring rate of the spring.

The geometrical relations present in the drive shown in Fig. 2 (A) when operating under a normal load and under maximum load are shown in Figs. 2 (B) and (C), respectively. For normal load conditions, the notations for dimensions and angles carry the subscript 1; for maximum load conditions they carry the subscript 2.

The geometrical relations existing are:

AT A NORMAL LOAD,

$$a_1 = (R + r)\cos\beta_1$$
$$h_1 = g - (R + r)\sin\beta_1$$
$$b_1 = \sqrt{s^2 - h_1^2}$$
$$p_1 = s\sin(\alpha_1 - \beta_1)$$
$$t_1 = r + s\cos(\alpha_1 - \beta_1)$$
$$c_1 = a_1 + b_1$$
$$\sin\alpha_1 = \frac{h_1}{s} = \frac{g - (R + r)\sin\beta_1}{s}$$

AT MAXIMUM LOAD,

$$\alpha_2 = \beta_2$$
$$a_2 = (R + r)\cos\beta_2$$
$$h_2 = g - (R + r)\sin\beta_2$$
$$b_2 = \sqrt{s^2 - h_2^2} = h_2/\tan\beta_2$$
$$p_2 = s\sin(\alpha_2 - \beta_2) = 0$$
$$t_2 = r + s\cos(\alpha_2 - \beta_2) = r + s$$
$$c_2 = a_2 + b_2$$
$$\sin\alpha_2 = \sin\beta_2 = g/(R + r + s)$$

Where

F = spring force or horizontal component of the reaction load exerted by the axle, lb
N = vertical component of the reaction load exerted by the axle, lb

the relations that satisfy conditions of equilibrium are

$$Gb + Tt - Pp = 0 \qquad (5)$$
$$P\cos\beta - T\sin\beta = F \qquad (6)$$
$$P\sin\beta + G + T\cos\beta = N \qquad (7)$$
$$\sqrt{N^2 + F^2} = S \qquad (8)$$
$$T = \mu P \qquad (9)$$

Substituting Eq (9) in Eq (6)

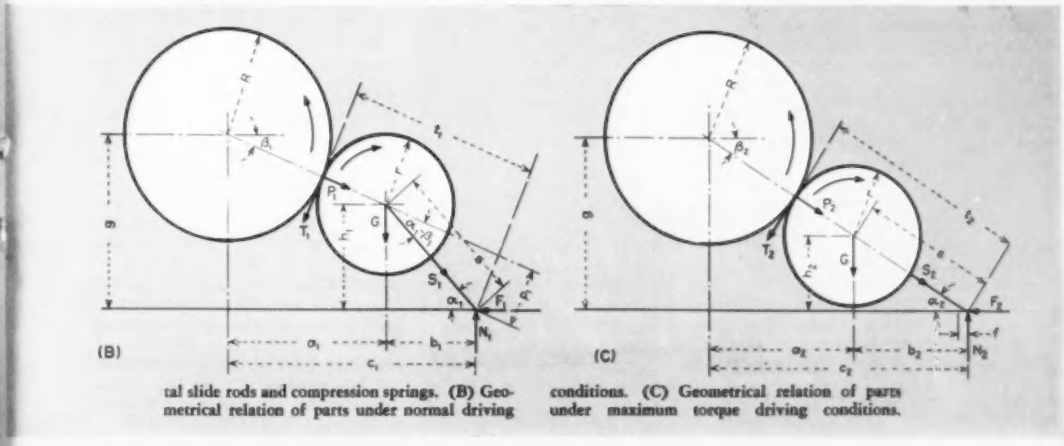
$$T_2\left(\frac{\cos\beta_2 - \sin\beta_2}{\mu}\right) = F_2 \qquad (10)$$

The spring force F_2 required to maintain sufficient radial pressure P_2 to transmit a maximum horsepower H_2 from Eqs (2) and (10) is then

$$F_2 = \frac{63{,}025\,H_2}{rn}\left(\frac{\cos\beta_2}{\mu} - \sin\beta_2\right) \qquad (11)$$

by similar analysis

$$F_1 = \frac{63{,}025\,H_1}{rn}\left(\frac{\cos\beta_1}{\mu} - \sin\beta_1\right) \qquad (11A)$$



tal slide rods and compression springs. (B) Geometrical relation of parts under normal driving conditions. (C) Geometrical relation of parts under maximum torque driving conditions.

The angle β_2 that gives the minimum value of F_2 for a given driving wheel diameter and speed at a given horsepower is found by differentiating Eq (11), setting the derivative equal to zero and solving for β_2, which results in the relation

$$\beta_2 = \sin^{-1}(\mu/\sqrt{1+\mu^2}) \quad (12)$$

Substituting values of μ of in Eq (12)

For $\mu = 0.3$, $\beta_2 = 16$ deg 42 min
For $\mu = 0.4$, $\beta_2 = 21$ deg 48 min
For $\mu = 0.45$, $\beta_2 = 24$ deg 14 min

Employing an angle β_2 as determined by Eq (12) will assure full utilization of the coefficient of friction of the material up to the limit where sliding may occur, while simultaneously maintaining minimum radial pressure and bearing loads.

Where

f = compression of the spring from spring load F_1 to spring load F_2, in
$f = c_1 - c_2 = a_1 + b_1 - a_2 - b_2$

the spring rate k is

$$k = (F_2 - F_1)/f \quad (13)$$

The foregoing analysis of the drive shown in Fig. 2(A) can be criticized on the basis that the design is expensive and that the vertical component N of the axle bearing reaction may introduce a frictional force that cannot be neglected. Furthermore, the analysis assumes that all the forces considered lie in the same vertical plane. Strictly speaking, the weights of motor, driving wheel, and swing base do not lie in the vertical planes that include radial pressure, tangential force, and spring force.

When the bearing rods are supported horizontally, however, these errors in assumption do not affect the spring calculations to a large extent when the friction wheel lies in a vertical plane that is central between the two bearing rods. These errors do, however, affect the magnitude of the vertical component N, which acts on the two bearing rods.

The friction wheel drive shown in Fig. 3 is supported by two bearing rods separated by the distance d. The axial thrusts on these rods are counter-balanced by the reaction of compression springs. Each spring, its adjusting nut, and its rod thrust plate are contained within a sleeve. When the motor and swing plate have fallen through, the sleeve can be removed by lifting it from its enclosure. By lifting the motor, the sleeve can be replaced in its enclosure without changing the spring setting.

By resolving all the forces present into their components acting parallel to the plane passing through the centerlines of the bearing rods and writing equations of equilibrium, the following relations are obtained:

$$G \sin \alpha_2 + T_1 \sin(\alpha_2 - \beta_1) + P_1 \cos(\alpha_2 - \beta_1) - F_{A1} - F_{B1} = 0 \quad (14)$$

taking moments about B

$$(d/2)\, G \sin \alpha_2 - d\, F_{A1} - e\,[T_1 \sin(\alpha_2 - \beta_1) + P_1 \cos(\alpha_2 - \beta_1)] = 0 \quad (15)$$

taking moments about A

$$(d/2)\, G \sin \alpha_2 + (d+e)\,[T_1 \sin(\alpha_2 - \beta_1) + P_1 \cos(\alpha_2 - \beta_1)] - d\, F_{B1} = 0 \quad (16)$$

dividing Eq (15) through by d and solving for F_{A1}

$$F_{A1} = \frac{G \sin \alpha_2}{2} - \frac{e}{d} \times [T_1 \sin(\alpha_2 - \beta_1) + P_1 \cos(\alpha_2 - \beta_1)] \quad (15A)$$

dividing Eq (16) through by d and solving for F_{B1}

$$F_{B1} = \frac{G \sin \alpha_2}{2} + \left(\frac{d+e}{d}\right) \times [T_1 \sin(\alpha_2 - \beta_1) + P_1 \cos(\alpha_2 - \beta_1)] \quad (16A)$$

For the condition at the instant of maximum torque when the swing falls through

$$\alpha_2 = \beta_1 = \beta_2$$

therefore Eq (15A) becomes

$$F_{A2} = \frac{G \sin \alpha_2}{2} - \frac{e\, P_2}{d} \quad (15B)$$

and Eq (16A) becomes

$$F_{B2} = \frac{G \sin \alpha_2}{2} + \frac{(d+e)\, P_2}{d} \quad (16B)$$

The stroke or deflection Δl of the spring between the initial load and the maximum load is

$$\Delta l = R + r + s - [(R+r) \times \cos(\beta_2 - \beta_1) + s \cos(\alpha_1 - \alpha_2)] \quad (17)$$

The spring constant for spring A is

$$k_A = (F_{A2} - F_{A1})/\Delta l \quad (18)$$

The spring constant for spring B is

$$k_B = (F_{B2} - F_{B1})/\Delta l \quad (19)$$

In similar manner, by resolving the forces into their components acting normal to the plane passing through the centerlines of the bearing rods and writing equations of equilibrium, the bending and twisting loads acting on the eyes of the bearing rods can be determined.

The maximum torque friction wheel drive is suitable and advantageous in applications where it is desirable to limit the magnitude of torque that can be delivered to a machine. This drive protects the machine from excessive steady loads and shock loads.

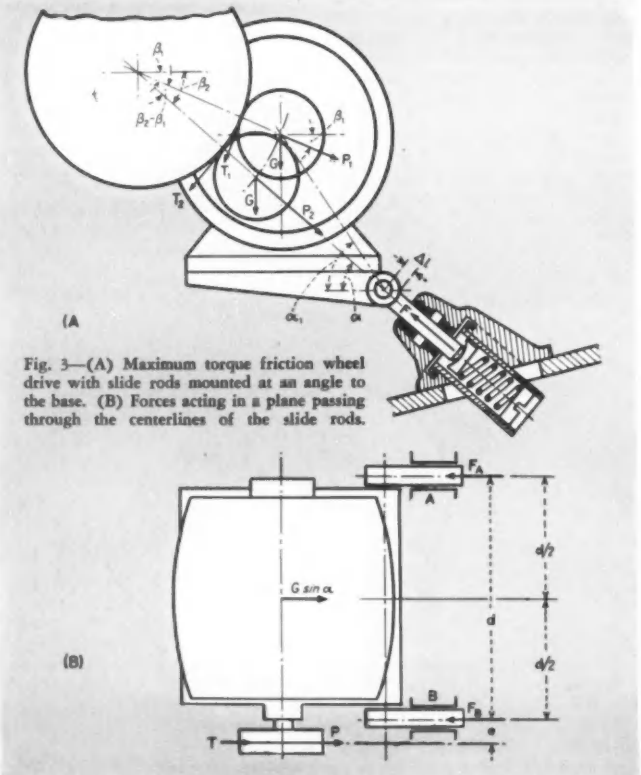


Fig. 3—(A) Maximum torque friction wheel drive with slide rods mounted at an angle to the base. (B) Forces acting in a plane passing through the centerlines of the slide rods.

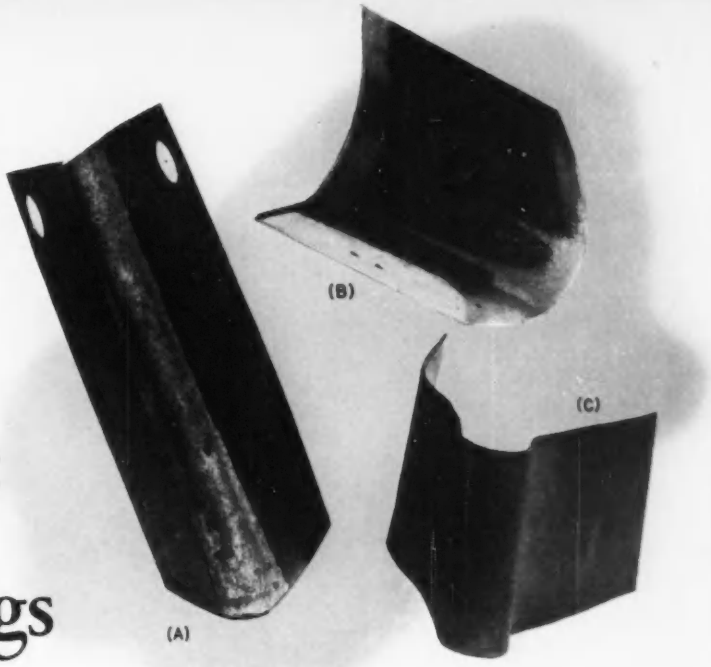


Fig. 1—Bend tests indicate the relative brittleness of Bureau of Standards ceramic coatings for steel. (A) Type A19 is subject to cracking on deflection on bending. (B) Type 520 is more flexible. (C) Type 417 is the best of the three from this standpoint.

Ceramic Coatings

For Metal Protection at High Temperatures

The life of components made from austentic stainless steels, Inconel, and other high temperature alloys has been extended as much as one-hundred percent by the use of sprayed or dipped ceramic coatings. The South Wind Division of Stewart Warner Corporation anticipates wide use in production operations.

THERE ARE TWO PHASES to the application of ceramic coatings to metals. One is the replacement of conventional but scarce high temperature materials having large amounts of nickel, cobalt, columbium, and other high cost elements with ceramic-coated low alloy steel. The other and equally important phase is the use of such coatings to extend the service life of these high temperature alloys, which are in critically short supply.

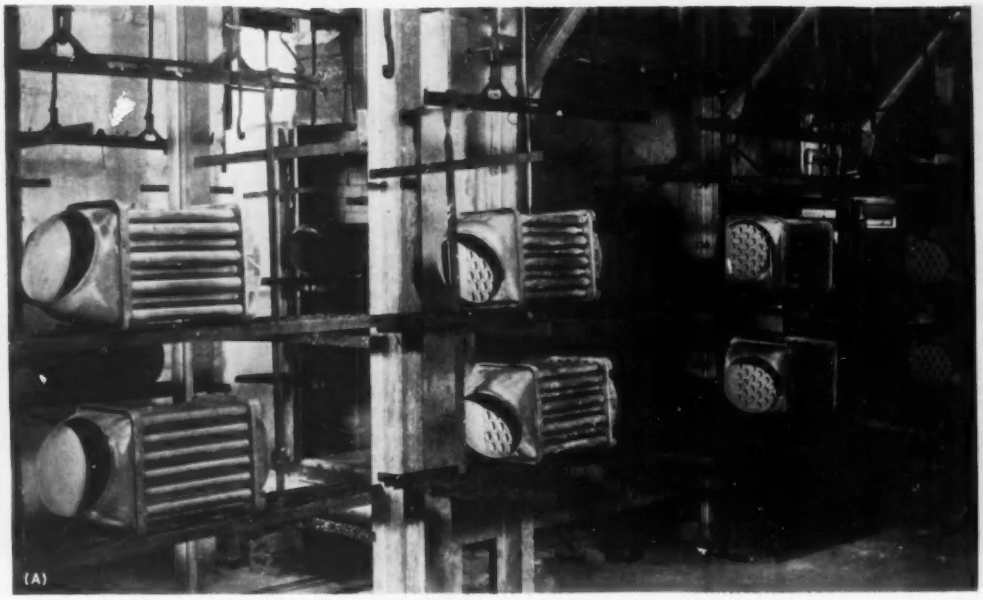
While work on the first of the above phases is still more or less in the experimental stage, considerable progress has been made on the second. For the future, ceramic coatings show promise for all types of heat exchangers, home heaters, locomotive and gas turbine components, combustion chamber liners, aircraft engine collector rings, and burner nozzles and jets, to name but a few potential applications.

The function of ceramic coatings in aircraft applications is to protect the base metal from intergranular corrosion at temperatures that range from 1,600 to 2,100 F. Sustained operations at these temperatures cause precipitation even in stabilized stainless steel and high nickel alloys. The rate of precipitation depends on the operating temperature and, in general, on the ratio of stabilizing agents such as columbium and/or titanium to the carbon that is present. Once precipitation occurs, the presence of corrosive agents such as lead bromides in the exhaust fumes from internal combustion engines speeds attack and disintegration of the intergranular structure.

Coatings to slow down the reaction, therefore, must (1) have good resistance to high temperatures (2) be able to withstand severe thermal stresses and (3) possess good resistance to chemical attack. In addition, in heat exchanger uses, the coating should be thin and have good heat transfer properties so that performance of the unit is not impaired.

Vitreous enamel coatings have good acid resistance, but are somewhat low in thermal shock characteristics. Also, their principal application has been at lower operating temperatures—on the order of 100 to 800 F. Many special coatings have been developed since 1945, but the disadvantage with most of these is that they must be fired at temperatures as high as 2,200 F. and above.

At present, the South Wind Division of the Stewart-Warner Corporation is using ceramic coatings for several types of aircraft heat exchangers that are an integral part of the aircraft exhaust system. So far as is known, this is the first large scale commercial use of such coatings. Work there has been confined to coatings developed by Harrison and Moore at the National Bureau of Standards,



namely types A19, A417, and A520. All of these mixtures are high temperature types for ferrous metals.

Coating A19 consists of 50 parts of a relatively soft or fusible frit, 50 parts of a hard or infusible frit, 25 parts of calcined alumina, 10 parts of enamelor's clay, and other minor ingredients. This material is applied in thicknesses from 0.001 to 0.0025 in. on high alloy metals such as 18-8 stainless steel, 25-20 stainless, Inconel, and Haynes Stellite materials such as Multimet N155. It fires at 1,650 F. and cannot be exposed to temperatures substantially above this without rapid deterioration, unless the time of exposure is short. Also, the coating is brittle and will not stand appreciable shock or deflection without chipping, Fig. 1. Therefore, it must be applied after the assembly has been fabricated.

NBS coating A-417 is composed of a high-barium, alkali-free frit (glass) with a 30 percent admixture of chromic oxide. This composition was selected on the basis of laboratory experiments in which a variety of compositions were studied, and the effect of various chemicals on heat resisting alloys was evaluated.

The coating is applied in the form of a water suspension, or "slip", and then fired. The result is a smooth, uniform, green-colored finish in controlled thicknesses between 0.001 and 0.002 inch. Indications are that it can be used successfully with any of the common heat-resisting alloys. The high firing temperature—on the order of 1850F—makes A-417 unsuitable for ordinary low-carbon steels; distortion and warpage would be excessive on all but the simplest shapes. Because of the firing temperature, also, an alloy with low oxidation resistance may present a problem; if an excessive amount of oxide forms before the coating fuses, the coating will be incapable of dissolving the excess, and adherence will be defective. This trouble can be avoided by controlling the furnace atmosphere.

Coating A-417 has better impact resistance and flexibility than A19 and can be operated at somewhat high temperatures. It can be exposed to

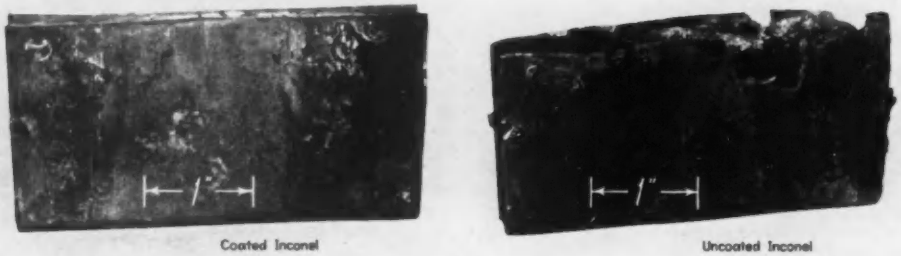
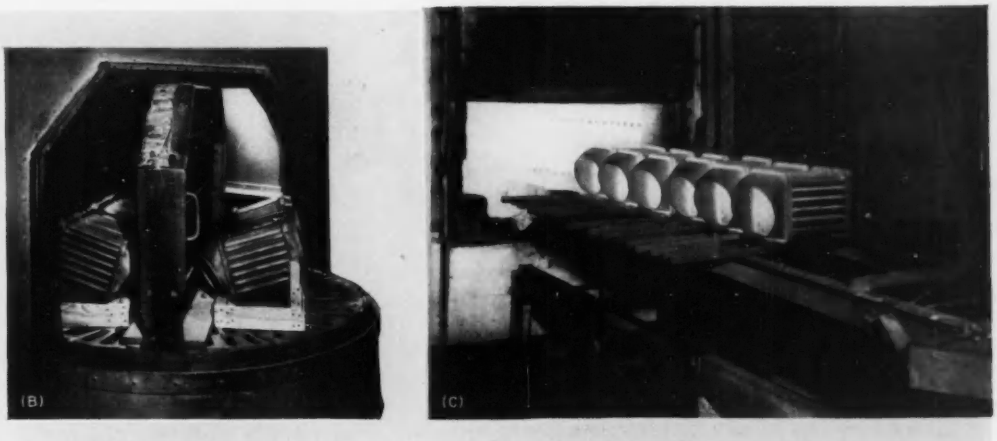


Fig. 2—Coated and uncoated Inconel after 232 hr. exposure to combustion engine exhaust gases at 2,200 F.



STEPS IN CERAMIC APPLICATION (A) Heat exchangers for military aircraft are conveyed to the annealing furnaces at the South Wind Division of Stewart-Warner Corporation. Life of these products has been materially increased by the use of ceramic coatings. (B) After annealing, the heaters are sandblasted to remove scale and provide a clean bonding surface. The next step is dipping or spraying of the ceramic. Coating used is Bureau of Standards A19 or A417. Base metal is stainless steel. (C) Heaters being removed from the firing furnace near the end of the production line. Ceramic coatings are fired like porcelain, the temperature depending on the type and composition of ceramic used.

temperatures 200 to 300 F. higher than firing temperature for prolonged periods of time without serious effect. This is the only one of the three coatings that can be operated above the firing temperature without corrosive attack of the metal.

There has already been enough service experience with NBS ceramic coating A-417 to establish its value in extending the life of high-temperature alloys. Further service tests now under way, carefully designed to eliminate undesired variables, will ultimately yield further quantitative data.

For example, tests were conducted by one of the aircraft companies on a ceramic coated Inconel heat exchanger under the following condition: 1,900 F. outlet from the engine; exhaust gas flow approximately 150 lb. per minute through each exchanger; and ventilating air flow of 20 to 25 lb per minute. There was one six-hour run during the test in which the exhaust gas immediately upstream of the exchanger was in the range of 2,200 F. with approximately 2,100 F. at the outlet end. After 590 hr. of operation, the exchangers (header plates and tubes) were examined for possible defects or failures. No failures were visible but the examination could not reveal whether any ceramic coating still adhered to the tubes. A tube and section of the header plate were removed from the right hand exchanger, since the exhaust system is designed so that the right hand exchangers are subjected to a more severe set of operating conditions. Tests proved that the ceramic coating was still present and that it had protected the exchanger from oxidation and intergranular corrosion.

The ceramic coated and uncoated Inconel plates, Fig. 2, were subjected to higher temperatures than in the previous test—in this case, 2,200 F. After 232 hr. of exposure in a combustion chamber in which the aviation fuel-air ratio was varied from 3 to 5 to 1 to maintain constant temperature, the uncoated plate was practically destroyed. Although the ceramic coating on the other was somewhat blistered and burned, the plate was in excellent condition. This perhaps is one of the most vivid illustrations of the advantages of these coatings.

One disadvantage of coating A-417 is that it is more difficult to apply than type A19. Therefore, when impact resistance need not be so great and operating temperatures are on the low end of the high temperature scale, it is preferred.

The third ceramic, A520, is somewhat less brittle than A19 but not as flexible as A-417. The same frit, but in different proportions, is used as for coating A-417. The firing temperature is 1,750 F. As yet, no clear picture of the advantages and limitations of this type compared with the previous types has come from the laboratories, and the coating has not been applied to a production item.

Application on Low Alloy Steel

The use of any of these coatings at high temperatures necessitates the use of a base metal that does not oxidize rapidly at high temperatures and does not warp and break the coating. In short, at temperatures of 1,600-2,100 F., a stainless steel or high alloy metal is required.

However, at lower temperatures, the base metal can be correspondingly lower in alloy content; ordinary low carbon steel coated with A19 ceramic is satisfactory for many products that operate up to 1,200 F. Surface pretreatment is similar; low carbon steel is sandblasted or acid pickled prior to application of the coating; a high alloy material is scaled at around 1,600 F. and sandblasted.

As a result, engineers anticipate use of ceramic coatings for base metal protection for such products as home heaters and other devices operating in the 1,200 to 1,400 F. temperature range. Coatings for abrasion resistance at elevated temperatures is another application; type A417 is difficult to sandblast off the base metal once it is applied and fired. Coal fired gas turbine components might be a logical use. And finally, coatings have been researched for other than good high temperature properties; an aluminum ceramic fired at 900 F., has excellent salt spray resistance. From all indications, the fields of use have just begun to be explored.

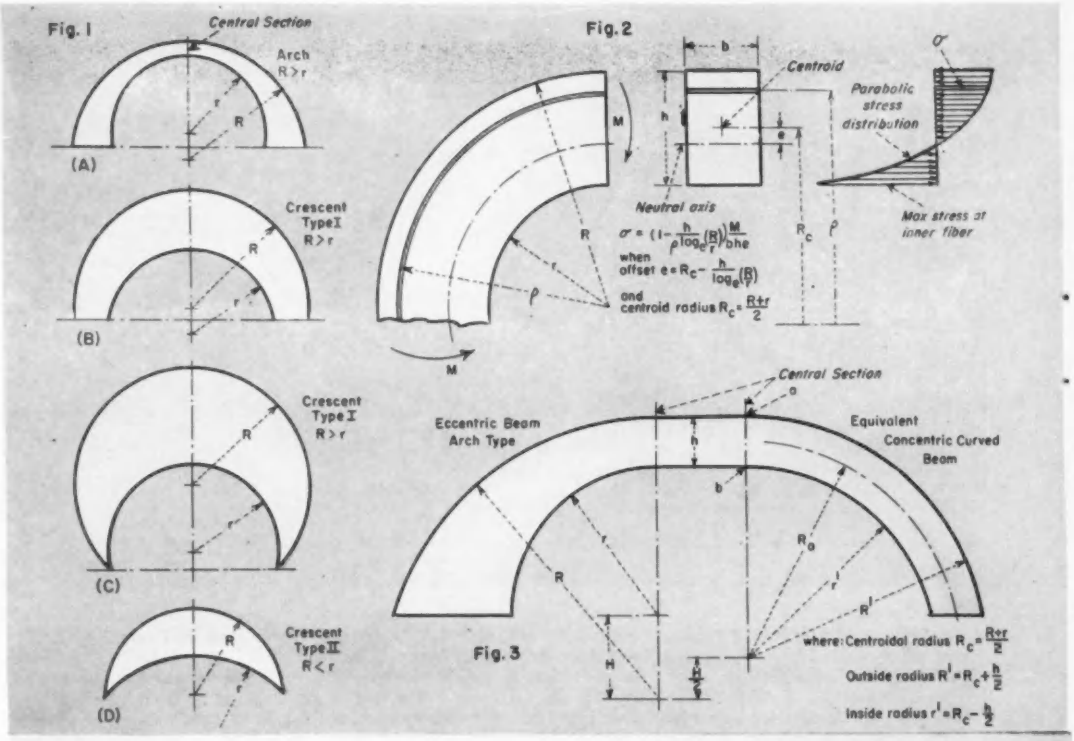


Fig. 1—Three types of eccentric, circular-arc curved beams. Crescent Type I has a larger outside radius; Type II, a larger inside radius. Fig. 2—Stresses in curved beam have a parabolic distribution. Fig. 3—Stresses in the central section of arch beams can be solved by means of an equivalent concentric beam having a similar cross section.

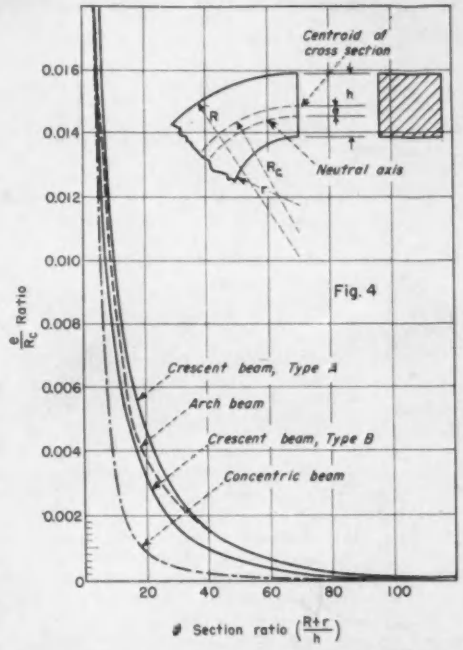
Bending Stresses in Eccentric

Graphical and analytical data that can be used to accurately calculate stresses in arch and crescent type eccentric beams.

TEST DATA have not existed in the past on which to base the design of eccentric beams, consequently approximations have been made using the concentric type of curved beam along with high factors of safety to compensate for the unknown variables. With the availability of recent data obtained by means of photoelastic models, a more accurate design can be made. The article: Models Simplify Deflection Analysis of Curved Beams, PRODUCT ENGINEERING, Sept. 1950, discussed only concentric types.

The main distinction of an eccentric beam is that the boundary arcs have different centers of curvatures. Besides this, the inner radius can be the larger one. Three basic types of eccentric beams are illustrated in Fig. 1. The arch type (A) has a thinner central section while the crescent beam is thicker. Crescent types can be further divided into: Type I where the outer radius R is larger than the inner radius r (B and C), and Type II where R is less than r.

Analyzing the stresses in eccentric beams is difficult because the radius of a fiber passing through a point varies with the location of this point. The center of curvature also changes. This internal geometry makes a strictly theoretical solution too complex for practical purposes. One method has been developed which utilizes an equivalent beam. This approach has proven satisfactory but only for the calculation of arch beams.



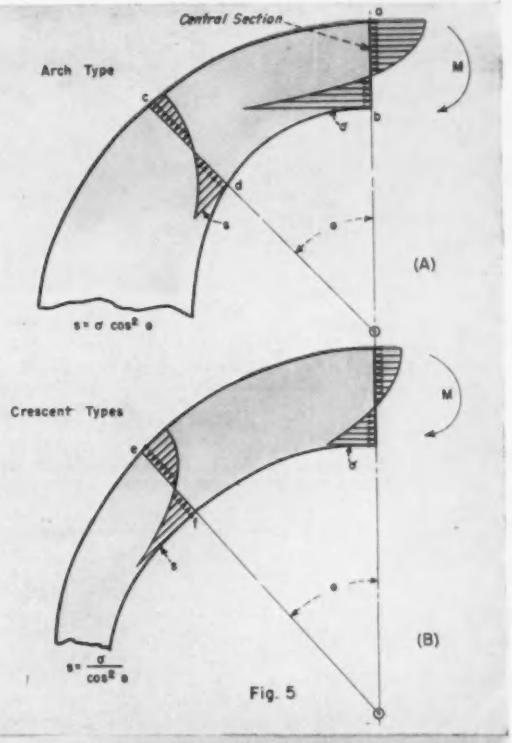


Fig. 4—Neutral axis of curved beams lies inside the centroid of the cross section area. Curves illustrate this offset distance for both the eccentric and concentric beams with rectangular cross sections. Fig. 5—(A) Stresses in a section away from center decrease in arch beams. Stresses in a section away from center (B) increase in crescent beams.

JOSEPH P. VIDOSIC
Purdue University

Curved Beams

This method of calculation is based on the Winkler-Bach theory for curved beams having concentric, circular-arc boundaries. It assumes that plane sections remain plane after bending. This equation for a beam with a rectangular cross section is given in Fig. 2 and will be called Eq(1). It can be used to calculate the fiber stress at the central section once the arch type of eccentric beam is converted into an equivalent concentric beam as shown in Fig. 3. The equation then becomes

$$\sigma = \left(1 - \frac{h}{\rho \log_e\left(\frac{R'}{r'}\right)}\right)\left(\frac{M}{bhe'}\right) \quad (2)$$

where σ is the fiber stress of the central section at radius ρ and the offset distance,

$$e' = R_c - \frac{h}{\log_e\left(\frac{R'}{r'}\right)} \quad (2A)$$

The other terms are defined in Figs. 2 and 3. These equations apply to the arch type of eccentric beams. To find the outside fiber stress at a (Fig. 3), the equivalent outside radius R' is substituted for ρ. Substituting r' for ρ results in the stress at the inner fiber b.

Another characteristic difference between straight and curved beams is that the neutral axis in curved beams does not coincide with the centroidal axis of the cross section. The distance between these two points is called the offset e, shown in Fig. 2. As a result of this offset, the stress distribution is not linear from the neutral axis but parabolic. This condition also holds true for eccentric beams, but the magnitude of e varies depending on the type of beam and the section ratio as shown in Fig. 4. This graph was determined from the photoelastic experimental models. Besides the curves for eccentric types of beams, an offset ratio is also plotted for the conventional concentric type of beam. The appre-

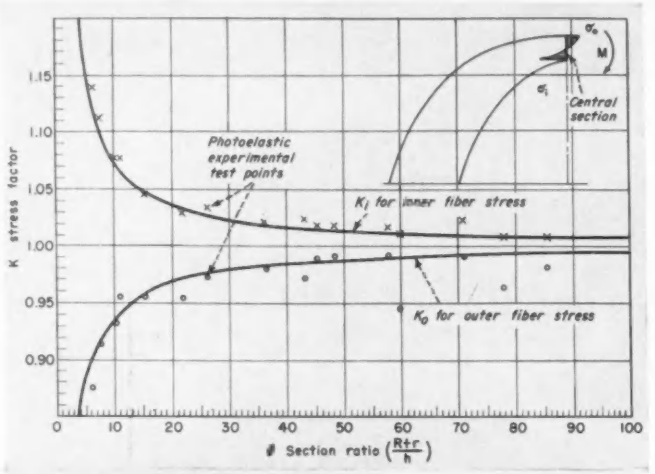


Fig. 6—Stress factors for the central section of the arch type of eccentric beams. Curves based on data from tests on photoelastic models.

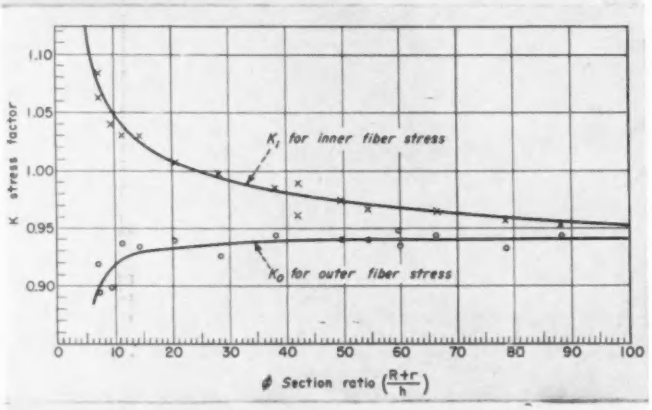


Fig. 7—Factors to calculate the inner and outer fiber stress at the central section of Crescent Type I beams.

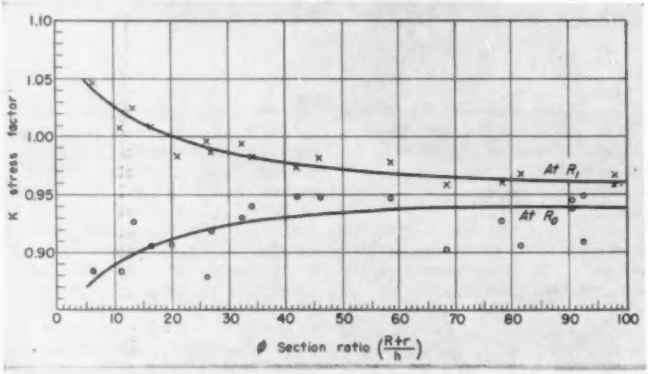


Fig. 8—Stress factors for calculating stresses at the central section of crescent Type II beams.

ciable difference between the two types indicates the magnitude of error which can exist in applying Eq(1) directly to an arch or crescent type of beam.

Fig. 4 can be used to determine e' for arch beams; however for greater accuracy Eq(2A) should be used. This graph serves another useful function: to locate the area of minimum stress for any holes that may be required.

In arch beams, the maximum stresses occur at the inner surface of the central section. At any other section, the stresses decrease in magnitude. To calculate stresses in section c-d, the values obtained from the central section should be modified by the equation shown in Fig. 5(A).

Unfortunately, Eq(2) is limited only to the arch type of beam. This equation, similar to the Winkler-Bach theory, neglects any radial and shearing stresses that may be present. From a practical viewpoint, however, the possible errors are negligible.

Graphical Solution

From the many photoelastic tests which were made on three types of eccentric beams, a series of charts have been prepared to simplify the stress calculations. With these charts it is only necessary to find the flexure stress that would ocur in a straight beam with the same cross section and subjected to the same moment. Thus the boundary-

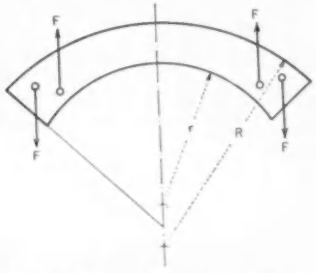


Fig. 9—Photoelastic model and location of the forces that were applied to produce bending in an arch type beam.

fiber stress at the central section may be calculated from:

$$\sigma = K \frac{M c}{I} \qquad (5)$$

or for a rectangular cross section,

$$\sigma = K \frac{6 M}{b h^2} \qquad (5A)$$

where,

σ = inner or outer fiber stress at central section, psi
K = stress factor, for either inner or outer surface (see Figs. 6, 7, 8)
M = bending moment, lb in.
$c = \frac{h}{2}$, half the beam depth, in.

I = moment of inertia of central section, in.^{4}
b = beam width, in.

ARCH BEAMS. The two curves in Fig. 6 are for finding the stress factor for either the inner K_i or outer K_o fiber stress. These factors are used with Eq(5) to calculate the fiber stress at the central section alone. To obtain the corresponding stresses at any other section Eq(3) listed on Fig. 5(A) is used. This conversion is necessary since the depth of the beam increases in the sections away from the central region, and the stresses should be reduced accordingly.

CRESCENT BEAMS. Plotted in Fig. 7 are the stress factors K_i and K_o which apply only to Type I beams. The corresponding factors for Type II beams are given by the curves in Fig. 8. As in the arch beam, these factors are used to find the stress at the central section. However, since this type of beam becomes shallower in depth in sections away from the central section, the stresses increase as illustrated in Fig. 5(B). Thus the central stress must be increased by the approximation given in Eq(4).

Although a wide range of section ratios were tested, each of the models was relatively short and consequently these data are limited and apply to a narrow region of approximately 10 deg from center. Since the stresses in crescent beams increase in sections away from the center, the simplified method of Eq(4) gives results which compare closely to the photoelastic tests in the extreme regions for Type I but yields values which may be about 10 percent less than the actual stresses in the Type II crescent.

These design data were obtained photoelastically using Columbia Resin, CR-39. Models of rectangular section were loaded in pure bending as shown in Fig. 9 in the loading frame of a standard polaroid-disk polariscope.

The model fringe values used to evaluate the test data were obtained from straight-beam models also subjected to pure bending. To eliminate the high initial creep of this material, all test readings were taken after the models had been subjected to a load for a period of thirty minutes.

Table I—Empirical Values of Stress Factor for Crescent Beams*

	Section Ratio $\phi = \frac{R+r}{h}$	Inner Stress Factor K_i
Type I	less than 20	$0.973 + 0.72\phi^{-1}$
	greater than 20	$1.09\,\phi^{-0.030}$
Type II	less than 20	$1.12\,\phi^{-0.058}$
	greater than 20	$1.08\,\phi^{-0.027}$

* To be used with Eq (5A)

Standardization Cuts Inventory of Extension Springs

TWO OF THE BASIC REQUIREMENTS of a mechanical spring are its capacity to support a given load at some specified deflection. In some instances, the only way to bracket a wide range of loads and deflections is to use a series of springs of the same type. When this condition occurs, the number of available sizes has to be large, making inventory difficult to control. Through a simple method of standardization, the American Steel and Wire Company of Cleveland has reduced the number of extension springs generally carried in stock to a reasonable total.

Neglecting initial tension, the load of a helical extension spring is a function of its deflection per coil. The same load, therefore, can be maintained with various lengths of the same spring provided there is a constant relation between total deflection and free length. This principle permits the spring designer to specify stock springs on the basis of their load characteristics only.

Table I shows eleven sizes of extension spring. These data replace more than 300 individual spring specifications, and still cover the same load range from 170 to 560 lb. Each of the eleven springs is designed so that those with a mean load up to 350 lb are extended 1.6 times their original free lengths, while those with a mean load of more than 350 lb are extended 1.4 times. Table II is based on these ratios and shows coil lengths corresponding to a number of different deflections for both groups of specifications. For example, a 30-in. section of spring No. 4 will pull 240 lb when extended 48 in. Similarly, a 60-in. section of spring No. 9 will pull 460 lb when extended 84 in. Variations from the mean loads can be obtained within the load range of each spring by making appropriate changes in the coil lengths as listed in Table II. A reduction in length naturally would increase the load and vice versa. Approximate adjustments for each 10 lb in load are determined by the percentages in Table I designated as "10-lb factor". Regarding other design factors as determined by basic spring theory, suitable wire sizes and spring diameters must be used to give safe stresses while satisfying the selected ratios of extension to free length for given applications.

Table I—Specifications for Eleven Stock Springs

Spring number	Mean load, lb	Load range, lb	Initial tension, lb	Outside diameter, in.	Deflection per coil, in.	Stress (uncorrected), lb/sq in.	10-lb factor, percent
1	180	170-190	25	1.99	0.332	97,000	7
2	210	200-220	30	2.18	0.360	96,000	6
3	240	230-250	30	2.35	0.390	92,000	6
4	270	260-280	35	2.56	0.420	90,000	5
5	305	290-320	40	2.78	0.453	89,000	4
6	340	330-350	45	2.89	0.472	89,000	3
7	380	360-400	50	2.92	0.438	86,000	3
8	425	410-440	50	3.08	0.463	86,000	2
9	460	450-470	55	3.22	0.480	85,000	2
10	495	480-510	60	3.37	0.503	85,000	2
11	540	520-560	60	3.52	0.525	85,000	2

Table II—Active Coil Lengths

Spring number	Deflection, in.	Coil Length, in. (loads to 350 lb)	Coil Length, in. (loads over 350 lb)
1	39	24.4	27.9
2	42	26.2	30.0
3	45	28.1	32.1
4	48	30.0	34.3
5	54	33.8	38.6
6	60	37.5	42.9
7	66	41.2	47.1
8	72	45.0	51.4
9	78	48.7	55.7
10	84	52.5	60.0
11	90	56.2	64.3

The above lengths and corresponding deflections will produce the mean loads shown in Table I. To increase (or reduce) loads by 10 lb, the active coil length is increased (or reduced) by an amount determined by use of the "10-lb factor." Two additional coils should be allowed at each end for clips.

AIRCRAFT ENGINE exhaust gas nozzle ring is the largest investment casting in production. It is made of type 309 stainless steel, weighs over 16 lb and has an outside diameter of 13.4 in. Good foundry control holds the concentricity of the inner and outer shroud rings within ± 0.010 inches. (A) Artificial Larynx made of manganese bronze. Long core makes this casting difficult. This is true of all parts containing long thin walled sections.

Wright Aeronautical Corp.

Investment Casting:

D. V. LUDWIG
Consultant

R. L. WOOD
Arwood Precision Casting Corporation

MANY INVESTMENT CASTINGS consist of parts that were originally designed for manufacture by some other process. This does not permit the most economical manufacture. To effectively use this process, two important phases must be considered: (1) alloy selection and (2) detail design or configuration. While the basic rules for good casting design apply with some modifications to the investment process, many foundry production difficulties are due to the careless choice of an alloy.

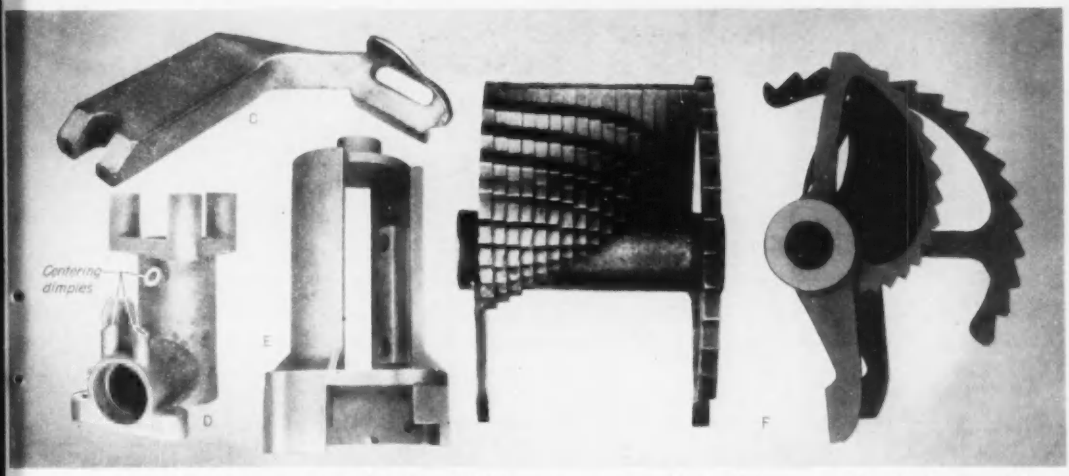
The physical and mechanical properties of investment cast alloys are essentially identical to those cast by other methods. One difference is a slightly enlarged grain size in some alloys which is the result of slow cooling in the investment process. This tends to lower the ductility or the permissible elongation; however, the hardness, ultimate tensile and fatigue strength are basically unchanged. In general, investment castings are more uniform in density and freer of major mechanical defects (such as blowholes, trapped inclusions and drosses) than other castings.

The differences in the physical and mechanical properties between alloys in the cast form and those in the forged or milled form are inconsequential for most applications. The tensile and yield strengths of the castings are approximately midway between the values based on mill specimens taken in the longitudinal and transverse directions. The elongation may be the same or as much as 50 percent less than materials with comparable hardness. Lack of grain orientation in investment casting may be responsible for a greater reduction in area: up to 100 percent more than normally obtained with machined specimen from mill stock. One beneficial feature of cast structures is that they are more reliable when subject to vibration. Properly filleted investment castings are less susceptible to notch sensitivity failures than when machined from forgings, mill stock, or from roughly dimensioned castings.

When considering which alloy to use, it is best to select one that is frequently cast in the particular foundry being used. To facilitate the selection, the most common alloys used are tabulated on pages 203, 205, and 207. These metals are separated into six groups and arranged in terms of their relative castability. The first alloy in each group is considered as the best from an investment casting standpoint. Many metals which are difficult to handle are not included. Some of these are: low carbon steels, yellow brasses, and the copper-aluminum alloys. However, this list is sufficiently large for a proper selection.

LIGHT METALS. In the light metals group, aluminum type 356 is the most desirable alloy. Rarely is there a reason for the use of other compositions. The properties of heat-treated Type 356 compares favorably with the chemical and physical properties of all other castable grades.

COPPER BASE ALLOYS. Several copper alloys are available. For industrial



To simplify casting, a temporary hole at *A* would help to support the core but would have to be filled in later. (B) Aircraft clutch arm is made of 4130 steel. Fine detail with cast steel does not compare with aluminum or silicon brass. (C) Industrial sewing machine casting was made with four different alloys before deciding upon the 52100 steel which has good wear resistance. (D) Hydraulic Cylinder and Valve Body of red brass was originally an assembly of 14 pieces. Centering dimples in small bosses facilitate drilling the holes. (E) Galvanometer Instrument housing made of 356-T6 aluminum. Internal bosses had to be held parallel within 0.002 inches. Finishing operations consist of tapping cast holes and drilling top pivot hole. (F) Cam for Varitype machine is made of silicon brass and replaced a part that was originally made of 19 stampings, pinned and brazed.

Alloy Selection and Design

Precision investment casting has proven to be ideal for many intricate machine parts. Here are important facts on selecting the alloy and designing the parts which often determine whether a part will be a satisfactory and economical one.

design problems, silicon brass is the most widely used grade. This alloy has the best combination of foundry properties and high physical strength. Beryllium copper responds well to heat treatment, and is chiefly of importance in making small, intricate springs and other parts requiring a spring temper or abrasion resistance.

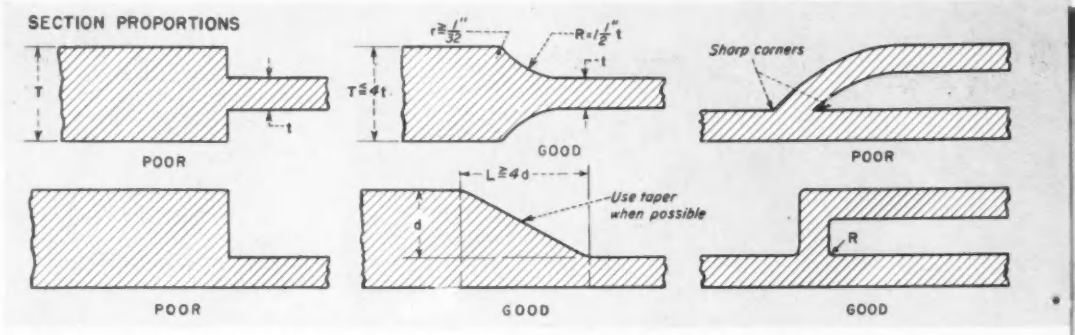
LOW-CARBON STEELS. One drawback to all of the carbon and low alloy steels is that they lose carbon at the surface from oxidation while the casting is cooling. Loss of one or more of the alloy elements is another important phase that determines foundry desirability. The non-alloyed steels are most sensitive to this decarburization. Steels with higher carbon have a more pronounced carbon loss. This loss can be made up by a final carburizing treatment. The 3100 and 4100 series are somewhat less sensitive to carbon loss than the 1000 series.

In replacing low carbon steels 1020 or 1120 for investment casting, one basic rule is to use an alloy steel of comparable hardenability and strength such as: 3120 or 4120. This substitution results in castings that are stronger, have better details, a smoother finish and are as economical as if produced of straight carbon steel.

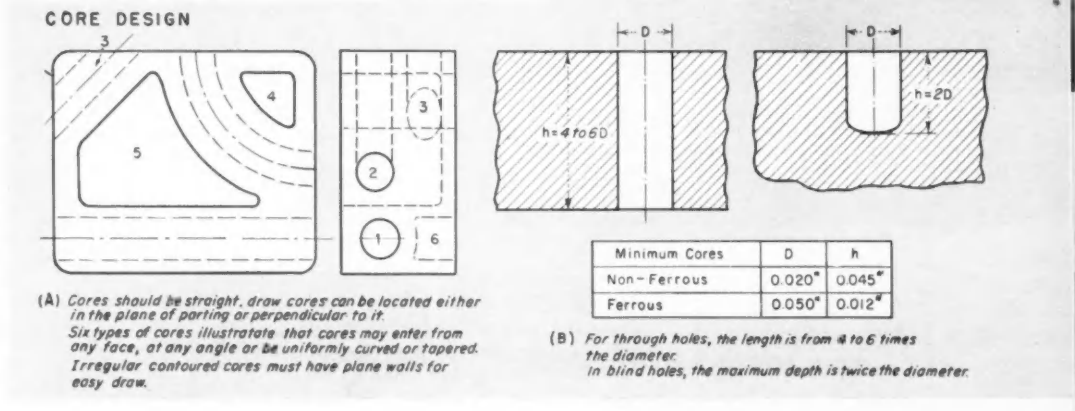
For designs that are highly stressed, the 4100 series should be used to replace alloys of comparable carbon content. SAE 4130 is one of the toughest investment casting ferrous alloys. For higher strength but with some sacrifice in shock resistance, SAE 4140 or 4150 may be used. These chrome-moly steels are generally recommended as replacements for all other 40 or 50 point carbon steels such as 1040, 3140, 4640, 6140 or 8640.

FERROUS TOOL STEELS—52100 is the recommended alternate for any carbon tool steel such as 1095. It is often used in place of Ketos, type 440F or Carpenter 610 where stainless properties are not important and where the good dimensional stability of Carpenter 610 is not required. The main reason for using 52100 is to reproduce fine details, since it has good fluidity. This alloy should not be used where impact loads are encountered. High-carbon high-chrome tool steels, such as Carpenter 610, and type 440F stainless steels decarburize so slightly that they may be readily hardened to Rockwell *C* 60 to 65 without the necessity of special treatments.

STAINLESS STEELS. As a general rule, the castability of the ferrous alloys improves with higher alloy content. An



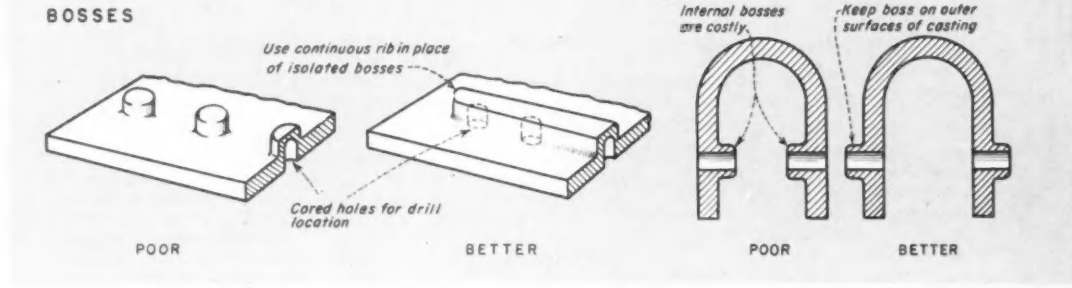
Changes in section thickness should not exceed 4 to 1 where uniformly high density is needed. Fillets, important in all good



Minimum Cores	D	h
Non-Ferrous	0.020"	0.045"
Ferrous	0.050"	0.012"

(A) Cores should be straight, draw cores can be located either in the plane of parting or perpendicular to it. Six types of cores illustratate that cores may enter from any face, at any angle or be uniformly curved or tapered. Irregular contoured cores must have plane walls for easy draw.

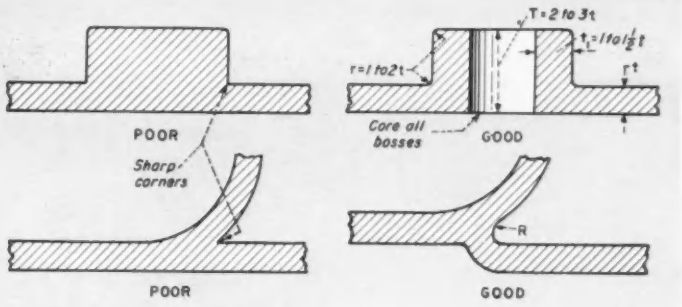
(B) For through holes, the length is from 4 to 6 times the diameter. In blind holes, the maximum depth is twice the diameter.



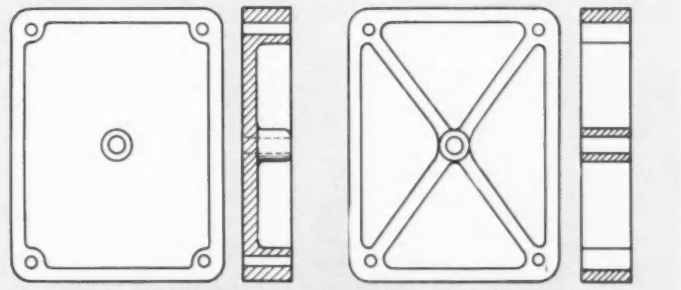
exception is that of stainless steel types 410 and 416. One drawback of these alloys is that of appearance: surface pitting. Type 410 is recommended for structural parts where such pitting is not detrimental. Of the ferrous base alloys, austenitic grades of stainless steel are most castable. There is almost no foundry difference between any of the types from 302 through 347.

HIGH TEMPERATURE ALLOYS. Refractory alloys are considered slightly less castable than the high alloy ferrous metals. However in foundries accustomed to these materials, the cobalt alloys present no problems. To date little information is available on the relative castabilities of these alloys. While nickel is beneficial to foundry properties of many alloys, nickel base alloys are not as fluid or controllable as the austenitic grades of steel. In general, where the special properties of cobalt or nickel base alloys are necessary, the final choice should be based on the recommendations of the foundry source rather than on the characteristics of the different compositions.

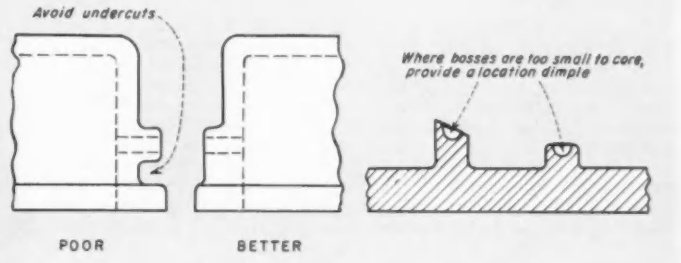
In general, the chemical properties of an alloy are not the only metallurgical phases which must be considered in selecting the material. In investment casting, comparatively small quantities of metal are prepared for each production run. As a result, any chemical instability of the molten metal is magnified. This is the main reason why carbon steels are unsuited for investment casting: they have an



casting design, should be used at all junctions to prevent cracking at sharp corners.



(C) *Avoid thick solid sections. Location of holes is difficult when the section is thicker than twice the minimum hole diameter. Two methods show how to reduce the mass.*



excessive affinity for gases. In addition, carbon and stainless steels (types 410 and 416) tend to have strong reaction with the melting crucible, pouring ladle liners and the mold materials. Above the eutectic composition, carbon steels are also very hot short and cause considerable scrap because of hot cracks in the castings.

Unfortunately there is no economical way to avoid the reaction between such alloys and the air, the crucible, the ladles or the molds. Where these reactions occur the castings are ruined through the formation of small slag droplets. Even when these droplets form on the surface, the resulting pits usually destroy their worth as precision castings where close tolerances are important.

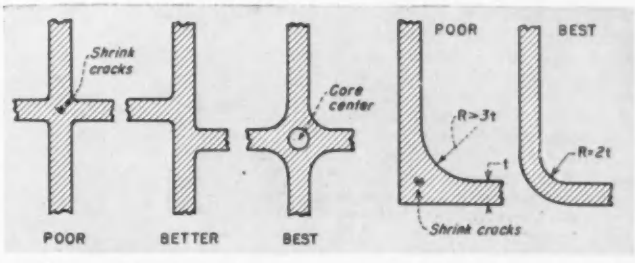
Some ferrous alloys are sensitive to metal turbulence encountered during the filling of the mold. This turbulence causes a formation of insoluble oxide particles which are too small to be detected in X-ray or visual examinations. Where such alloys are used for structural parts, fracture tests of sample castings must be made to insure adequate cleanliness in production pieces. One way to insure sound parts is by altering the casting gates to eliminate the metal turbulence.

Another phase of metallurgical chemistry is in controlling the fluidity of each alloy used. Those which remain sluggish after melting do not respond to de-gassing or de-slagging treatments and require either superheating or the precise additions of trace elements for control. Consequently such alloys are usually unsuited for investment casting because of high scrap rates. Since there are from 40 to 50 manual operations in setting up an investment mold, more than 70 percent labor has been spent when the metal is poured. Thus losses from poor fluidity are most expensive. This waste is unnecessary since there are many castable grades of material from which to choose.

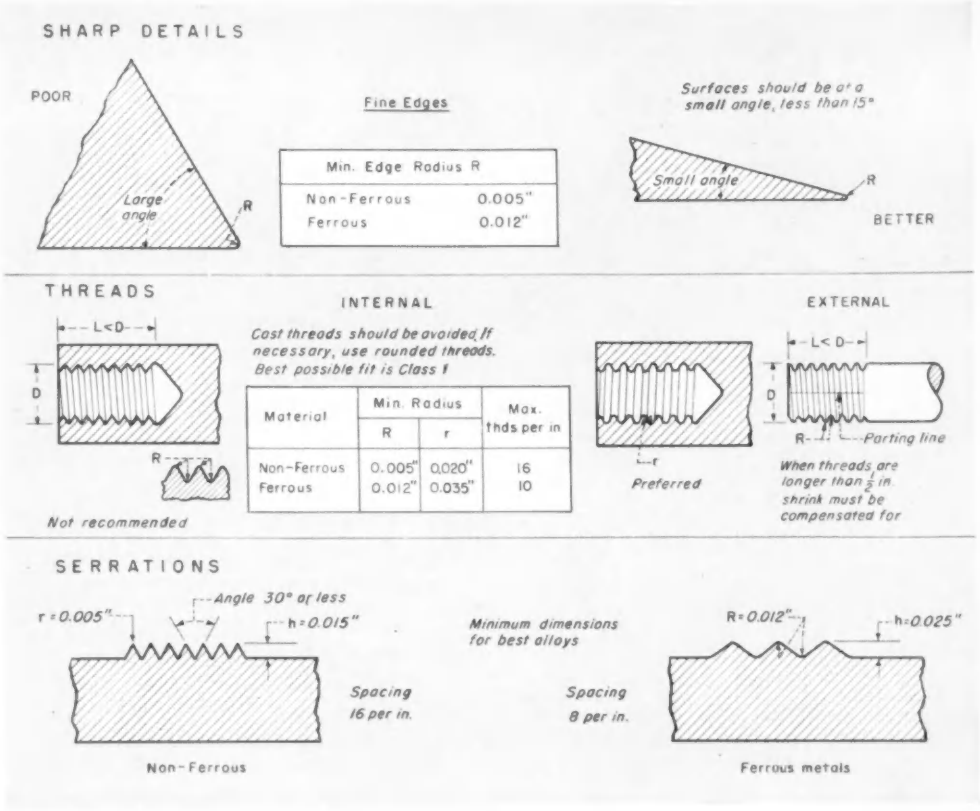
Design Details

In converting parts that were previously stamped or machined to the investment process, it may be possible to combine several individual pieces into one casting. This consolidation has often resulted in cheaper parts even though stainless steel was used in place of a low carbon steel. Two examples shown in (D) and (F) on page 185 illustrate machine parts which were previously made up as an assembly of many parts.

The basic rules of good casting design apply to the investment process.



Avoid concentration of mass at the intersection of ribs or corners to prevent cracks.



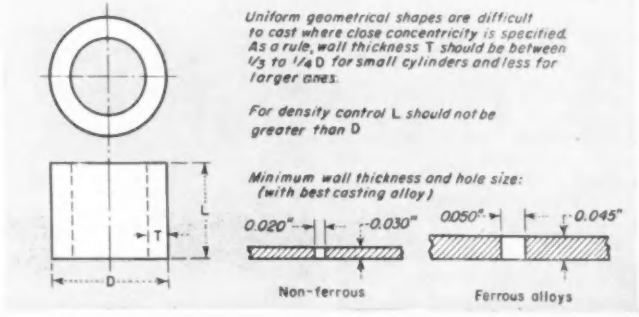
However, to get the best results, certain additional considerations must be observed over those of the commercial casting method. An important point in investment casting is to avoid unnecessary mass. This is in line with the principle of reducing as much machining as possible. The total surplus metal to be removed by cutting or grinding should preferably be limited to about 2 percent of the casting weight. It should never exceed 20 percent.

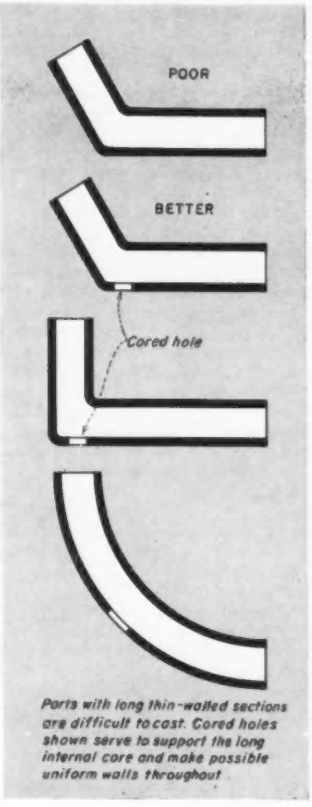
One way to equalize the mass and reduce the excess metal is by using cores in holes and bosses. In some cases, heavy sections or extended wall areas can be either cored or designed to be cast with a series of holes. This method can be used only in uncritical areas so that the strength of the part is not lowered.

In cored holes, the diameter and length are determined by the area and thickness of the casting. For example, it is difficult to cast small holes in thick sections, as well as to accurately hold the location of these holes. The minimum hole diameter in ferrous and high temperature alloys is 0.050 in. In low temperature, high fluidity non-ferrous alloys, holes as small as 0.020 in. can be cast in thin sections (0.030 in. to 0.060 in. thick). The ratio of length to diameter of self cored holes is 4 or 5 to 1. Blind holes seldom can be cored effectively where the depth of the hole is greater than twice the diameter.

Holes are often used in the as-cast condition and fitted with solid pins or bolts. Here the surface roughness inside the hole must be considered to attain a good fit. This roughness interferes with the measurement of the hole and, consequently, the true diameter of cast holes is often greater than the apparent or measured size.

Holes that are to be finished by drilling, reaming or tapping should be cast sufficiently undersize to insure com-


Uniform geometrical shapes are difficult to cast where close concentricity is specified. As a rule, wall thickness T should be between 1/3 to 1/4 D for small cylinders and less for larger ones.
For density control L should not be greater than D
T
L
D
Minimum wall thickness and hole size: (with best casting alloy)
0.020"
0.030"
0.050"
0.045"
Non-ferrous
Ferrous alloys



Parts with long thin-walled sections are difficult to cast. Cored holes shown serve to support the long internal core and make possible uniform walls throughout

plete clean-up. On machinable alloys there is seldom any economical gain in coring holes which will be subsequently drilled. The only advantage would be for uniformly locating holes on small bosses; often a location dimple is used for this purpose. In non-machinable ferrous or refractory castings, the cored hole may have to be used in the as-cast condition and may be the only type of hole which is economically possible in this case.

Recent developments in preformed ceramic and glass insert cores has improved the possible depth to diameter ratio of holes. Where such cores can be used the holes formed are usually held straighter, smoother and with closer tolerances than those formed by the mold material. However, the cost of dies for the insert cores, and that of manual labor in inserting these cores in the patterns prohibits their use for short production runs in most materials. Occasionally a preformed insert core is needed in a design using a refractory alloy. Where no other way exists to form the desired hole, the insert is a valuable production tool. The present minimum diameter for round inserts is $\frac{3}{32}$ in. Symmetrical shapes other than round can be obtained with such inserts.

The minimum wall thickness for most ferrous as well as high temperature alloys is 0.050 in. The non-ferrous alloys are more fluid and often cast with large wall areas as thin as 0.030 in. Tapered walls and edges may be down to 0.012 in. in ferrous alloys and 0.005 in. radii for non-ferrous alloys.

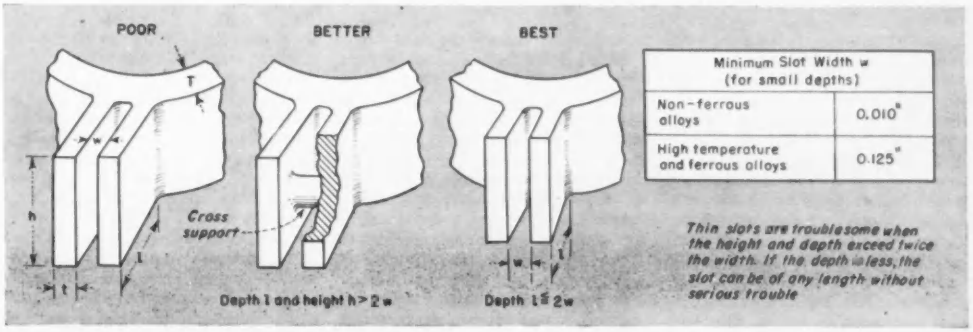
Fillets are important in all good casting design. In investment castings, a minimum fillet of $\frac{1}{32}$ in. is required but for most parts a radius of $\frac{1}{16}$ to $\frac{1}{8}$ in. is desirable. The fillet radius can be found from: $r = 2T$ where T is the thickness of the wall or the walls being joined. Excessive fillet radii may induce shrink cracks; this is particularly true when casting ribs on thin wall sections of 0.050 to 0.030 in. thick.

Cast threads and serrations are troublesome details for the high temperature metals. However, with machinable, low-temperature alloys such cast details are seldom justified. There are exceptions where some unusual designs, special thread form or special serrations must be cast. Good details are easily obtainable in the non-ferrous alloys of aluminum or copper but are not possible with ferrous or refractory metals. This difference is the result of the foundry technique of those metals which are castable below 2500 F and those which must be cast above that point. For the lower temperature group, the investment mold is a single slip with gypsum, whereas the high temperature investment is made with a double slip using silica or porcelain clays.

The frozen mercury pattern with shell investment process can produce ferrous, refractory and non-ferrous castings with very fine threads, serrations and other details which are not obtainable with the conventional wax or plastic patterns and block investment molds. Economic considerations limit use of this mercury pattern technique to larger castings and those special problems not suited to the wax pattern techniques.

All flat or uniformly curved surfaces are difficult to cast without minor surface irregularities. These defects may only alter the appearance, yet they are often the sources of controversy. Where smoothness is unnecessary, specifications should indicate that some defects (maximum depth or area) will be tolerated. One way to avoid this situation is to interrupt the smooth areas with stiffening ribs or to core out sections of the surfaces which are not needed. When the section thickness changes, it is best to taper thick to thin sections. Otherwise fillets must be used. Often heavy sections can be substituted by a suitably ribbed thin one. One point to remember is that heavy sections should never be connected by light sections. In casting, such designs prevent adequate feeding of the separated heavy sections. The use of chills, chaplets or other sand foundry devices are not practical in the investment process.

Involved internal passages are difficult to core in the investment process.



Minimum Slot Width w (for small depths)	
Non-ferrous alloys	0.010"
High temperature and ferrous alloys	0.125"

Thin slots are troublesome when the height and depth exceed twice the width. If the depth is less, the slot can be of any length without serious trouble

Such passages usually require cores that must be capable of straight line withdrawal. In special cases, passages may be cored where the pattern core can be moved on a uniform curvilinear path. This type of passage must be predicated upon curves derived from conic sections. Another approach is the use of soluble preformed insert cores to obtain complex core passages, usually in the unmachinable alloys.

Sometimes the pattern die may be designed with a multiple part collapsible core, but these are costly for most applications. Where cores other than the straight drain type are required, it is usually best to design the pattern equipment to produce the waxes in sections which are then "welded" to make the completed pattern. In this way almost any degree of internal core complexity can be reproduced. However, the removal of such cores becomes a problem that should be avoided whenever possible.

Draft is not as important in investment casting as in other foundry processes. One large foundry considers draft to be unnecessary even for the production of wax or plastic patterns. However, most investment foundries require a draft of ½ degree to facilitate the removal of patterns with a minimum of distortion. Designers should consider the requirements of their foundry, and indicate the sections which may be drafted.

Parting lines are not necessary in investment casting, but they are necessary to produce the disposable patterns. In well designed, well maintained dies, the parting line does not affect the casting. As a rule it is impractical to hold the exact tolerance at the parting line. The deviation at this point is about 0.010 in., depending on the quality and age of the pattern dies.

Gates are required to admit wax to the die and metal to the mold cavity. Since the gate removal distorts the metal in this vicinity, the tolerance cannot be held closer than ±0.010 in. unless precision machines are used. On small parts, gates can serve as a chucking lug to hold the casting for finishing operations.

THE SURFACE FINISH of investment castings is similar to that of a light, sand-blasted matte finish which results from the removal of the investment mold material by blasting. Usually the marks left by filing, grinding or other casting finish operations are blended by a tumble-blasting operation to give the parts a more pleasing look. The surface finish is determined by the relative castability of the alloy being cast, usually it ranges from 60 to 90 micro inches. Exceptionally smooth surfaces are possible in special cases by using porcelain-shell type of investment molds with frozen mercury patterns. This technique makes possible fine threads and fine serrations in steel alloys.

Metal allowances for finishing operations should never exceed 0.025 in. on any surface and normally should range from 0.010 to 0.015 in., depending on the metal smoothness castability, and casting detail. Many small non-ferrous castings of highly fluid alloys (such as silicon brass) can be cast with only a 0.005 in. allowance. Since it is no more costly to remove the greater depth, it is wise to use 0.010 or 0.015 in. for most finish tolerances. This prevents the production of castings that will not clean up in final machining.

Dimensional Tolerances for investment castings are usually quoted in terms of plus or minus 0.002 in. per inch for low temperature non-ferrous parts and plus or minus 0.005 in. per inch for ferrous and high temperature alloy parts. In small fractional dimensions, it is not practical to expect closer than 0.002 in. because of the roughness. On larger, and well-designed parts made from preferred alloys, closer overall tolerances are often held. There are over twenty variables in the production of an investment casting. Most of these can be controlled by the design engineer working closely with the foundry engineer. However there will always be slight variations in size from piece to piece and from lot to lot of investment castings.

Under commercial foundry conditions, it seldom is possible to produce investment castings with tolerances of ±0.001 in. Since such tolerances are functional it is best to allow stock for machine finishing to the final limits.

There is no need for drawings with the note that: all tolerances not otherwise specified must be held within 0.002 in. Best practice is to specify only the critical dimensions, and allowing the non-functional surfaces to fall within the normal variation. In this way the price of castings will be much lower. Once production has been established on a particular casting, the variation will probably range from 0.002 in. on small parts to 0.010 in. on very large ones.

When designing investment castings and when preparing jigs or fixtures for finishing operations, the "spread" of sizes which will be encountered should be considered. Where castings have been ordered with a permissible as-cast tolerance of plus or minus 0.005 in. on any particular dimension, the entire spread of 0.010 in. will be found during some point in the production run. While some small lots (perhaps the sample supplied for approval) may fall within 0.001 in. of the base dimension, the full range of the tolerances specified can be expected over a period of time. The finishing tools must be made adjustable to chuck those parts which are larger and those which are smaller than the mean dimension.

New Instrumentation Speeds Guided Missile Development

A WIND TUNNEL balance approximately 10 times more accurate than the type customarily used in supersonic wind tunnels has recently been developed at the Naval Ordnance Laboratory, White Oak, Md.

Extremely accurate measurement of forces exerted on the models is required because the range of the missile, its stability in flight, and the size of the "pay load" it can carry is increased as the drag on the missile is decreased. In the NOL Wind Tunnel, models of guided missiles are tested to select shapes for further development which will produce the least drag.

The balance holds the model on a sting. The sting is supported in the balance housing by lubricated rotating surfaces which effectively eliminate static friction. The exact amount of the aerodynamic drag force can therefore be transmitted through the sting to a precision spring which is deflected by an amount proportional to the drag force. The spring deflection is then measured electronically with an accuracy of 1/100,000 of an inch.

A precision Micro-Manometer, capable of measuring absolute pressures in a range of 1/10 mm to 10 mm of mercury, is used with the balance. The Manometer, also developed at NOL, has a quick response time because the small space above the liquid allows the air to be pumped out rapidly. Quick action is important in supersonic wind tunnel work since it decreases the time required for a test blow and makes it possible to get more data in a limited period of time. The surface pressure data for models in the wind tunnels is converted mathematically to determine the drag exerted on the full scale missile in flight.

In large industrial electronic controls, the mechanical problems encountered rival those involved in major machines. Above is motor control unit employing hinged panel construction, one of the newest trends in design of industrial electronic equipment.

Mechanical Design Aspects Of Electronic Controls

M. GOLDSTEIN
Control Department, General Electric Company
Schenectady, New York

AIM OF THE MECHANICAL ENGINEER is to obtain electronic controls that are as reliable, rugged, compact, easy to service and convenient to use as mechanical, hydraulic and pneumatic controls. Much progress has been made toward this goal, as can be seen from new developments in components, circuit layout, enclosure design and assembly and wiring methods.

Tube sockets are among the parts for which the product engineer is normally responsible. Although many of the standard radio type tube sockets are used today in electronic controls, there is an increasing tendency to use the newly-designed industrial tube sockets, such as those in Fig. 1. One of the most common tube sockets is the standard octal or 8 point tube socket. This socket has solder tabs as connection points and utilizes a molded body of phenolformaldehyde compound. In many cases, however, it is necessary to provide higher dielectric constant, leakage resistance, and resistance to arc carbonization. When this condition is encountered, an octal socket having a body molded of melamine resin performs satisfactorily. This socket is particularly suited to phototube applications, where even small current leakage between pins may be detrimental to the overall operation of the control.

In many of the larger electronic equipments, screw connections are preferred to soldered connections, their main advantage being easy serv-

Fig. 1—Tube sockets designed for industrial purposes. Elongated holes in socket at left accommodate two sizes of tubes.

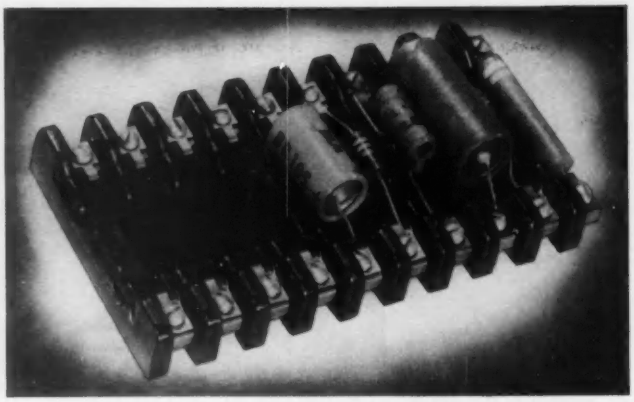


Fig. 2—Mounting board for resistors and capacitors provides for neat arrangement and easy maintenance of these components. Note use of terminal screws in place of soldered connections for simplification of replacement procedures in the field.

iceability in the field. For these applications the industrial-type octal socket, second from the right in Fig. 1, is recommended. This socket is molded of melamine resin. The generous-sized barriers between terminals provide ample creepage in accordance with the specifications of the National Electrical Manufacturers Association. Terminal screws are turned into separate U-type speed fasteners, which fit over the ends of the clips that engage the tube pins. The nuts can be turned over so that the heads of the terminal screws are on either side of the socket. This facilitates surface or flush mounting of the socket.

For larger size tubes, such as phanatrons and thyratrons, special sockets have been developed. The socket shown at the left of Fig. 1 is unique, in that it takes two different tube base sizes, A4-10 and A4-18 RMA (Radio Manufacturers Association) standard base size. This feature was obtained by using elongated holes in the molded part so that the pins of either size tube could enter to engage the contact clips. Each contact clip has two grooves or guides into which a tube pin can enter, depending upon which size tube is being used. The contact clip itself provides four line contacts on each tube pin. This keeps contact resistance low and increases current-carrying capacity and heat dissipation, necessary for the high current gas filled tubes. This clip is made of silver-plated beryllium copper. Screw terminals and reversible speed fasteners are used to allow surface or flush mounting of the socket.

Often, special consideration must be given to the mounting of resistors and capacitors. In Fig. 2 is shown a specially designed mounting board, available with different numbers of terminals. The terminal screws fit into specially designed U-type stamped nuts. Resistors and capacitors are mounted in this board by merely slipping the wire lead under the nut and tightening the terminal screw. This feature simplifies maintenance and replacement in the field. The mounting board is molded of phenol-formaldehyde compound and ample barriers are used between terminals to provide proper creepage distances. This design provides a rugged, heavy-duty mounting board for small resistors and capacitors.

Terminal boards are used extensively in electronic controls to provide connection points for the customer's incoming and outgoing wires and also to provide a means of interconnecting various panels in a system. All of the terminal boards in Fig. 3 are similar in that they are molded parts incorporating riveted-in or molded-in terminals. Some are available with a solder tab on one side of the board and a screw terminal on the other. The smaller boards are used in low voltage, low power control circuits, while the larger boards are generally used on power and high voltage connections. A number of the boards are provided with terminals, which will accept the stripped end of a wire. Others make use of spade or ring-type terminals crimped on the ends of the wires.

Stand-off and feed-through insulators are available in a large range of sizes, voltage ratings and materials, as pictured in Fig. 4. The most commonly used materials are the various phenol-formaldehyde compounds, steatite and porcelain. Where shock and vibration are present, the molded type insulators are preferred. However, in some very high voltage applications it is necessary to use porcelain insulators, even though shock and vibration are present. In these instances, it is necessary to take adequate precautions to protect porcelain insulators from damage by mounting them on cork or rubber pads.

Panel Design

Once all the components for a control have been chosen, the fundamental considerations of panel design reduce to three factors—the arrangement of the panel (which serves as the mounting for the components), the method of mounting the panel in an enclosure, and the choice of a suitable enclosure.

There are two broad panel classifications, the flat panel and the "designed-in-depth" type of panel. The former is basically a flat sheet of steel, or occasionally of an insulating compound, suitably pierced with holes for mounting the circuit components. This is the less expensive type of panel, from the standpoint of cost of the panel itself. Also, the assembling and wiring of components is accomplished more economically, since there is ample area and space to work in. Components are mounted so that all wiring and connections are on one side of the panel. The flat panel finds widest application in the larger apparatus, such as welding controls and large motor controls.

The "designed-in-depth" panel is used when compactness is desired. It consists of two or more separate panels arranged one over the other so as to supply multiple planes for mounting

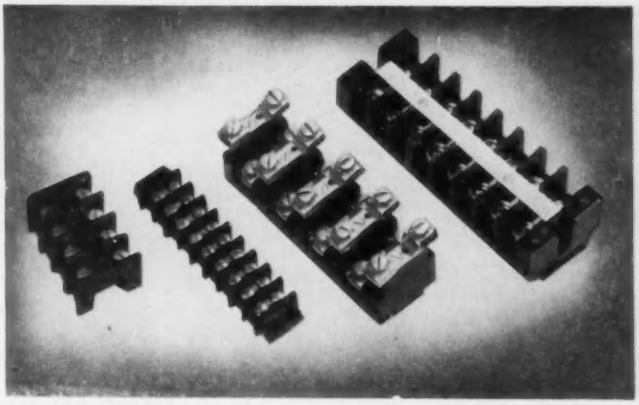


Fig. 3—Terminal boards provide connection points for incoming and outgoing wires and for wires between components and subassemblies. These are seldom found in consumer electronic assemblies where almost all wiring is direct from part to part.

components. Or, it may be a one-piece panel so formed as to supply multiple mounting planes. This arrangement reduces frontal area and makes maximum use of the volume of the associated enclosing case. This type of panel is more expensive than the flat panel and imposes greater hardships during assembly and wiring of components because of restricted space for finger and tool access. Where the deep panel is used, the designer must seek clever layouts that minimize assembly difficulties. This type of panel is used largely in the small devices such as photoelectric relays, electronic timers (like that of Fig. 5), electronic relays, and fractional horsepower motor controls.

The choice of a method of mounting the panel in the enclosing case depends upon the physical size of the panel and the relative importance of ease of servicing and repair. In the small devices, the panel is usually bolted to the back of the enclosure with three or four bolts. The panel generally is mounted by means of slots or "keyholes" so that it is only necessary to disconnect the wiring, loosen the bolts slightly, lift the panel up a bit, and withdraw it from the case. This method of construction is economical to manufacture, but is difficult to service if it is necessary to get at the back of the panel often.

To obtain greater ease of access to the back of the panel, a hinged panel mounting can be employed. In this construction, the panel is hinged to the enclosing case along the side, or along the bottom. The free side of the panel can be held in the enclosing case by bolts, latches, or quarter-turn (aircraft) fasteners. This type of mounting is frequently seen in the medium and large size equipments, but on occasion has been used also in the small equipments.

High serviceability is attained by the use of rack mounting with plug-in units. In such assemblies, the electrical circuit is divided into its basic functional units, such as control unit, power supply and servo amplifier. Each unit is built as a separate panel, often with slides on its lower surface for horizontal mounting. At the rear of each unit, all interconnecting wires are terminated in a plug rather than a terminal board. The enclosing case contains a suitable structure of guides. Each panel slides into position on these guides. Properly located receptacles couple the plug on each panel. The receptacles are wired together so that each unit, when plugged in, is properly interconnected with all the other units that make up the complete control. Thus, if a particular unit in the equipment fails or develops trouble, it may be quickly removed and a spare unit plugged in. Production can go on uninterruptedly while the faulty unit is serviced. This type of construction has been used in welding controls for the automotive industry. The cost of rack mounting is high.

Panel Manufacturing Methods

The designer must recognize the fact that, at present, electronic controls are produced in low and medium quantities. Rarely does the production of any one device exceed 10,000 per year. Also, control manufacturers generally build a large variety of controls. This is true even of the smaller firms. The type of manufacturing equipment used together with the accompanying tooling plays a very important part in the final costs of the products. Thus, in the interest of cost it is necessary that the method of manufacture be considered carefully during the design stage.

Most panels are made of sheet steel, with thicknesses ranging from 0.032 to 0.125 inches. These panels are cut to size on power shears. On low quantity runs, very effective use can be made of turret presses for piercing operations. A selection of the most commonly used holes or groupings of holes can be kept in the turret at all times, thus minimizing the set-ups required. A moving bed on which the

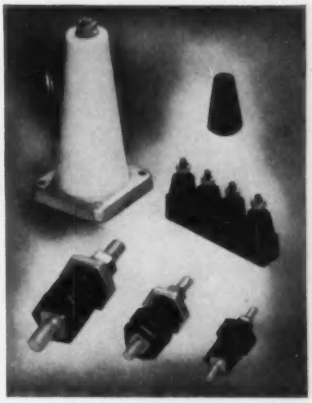


Fig. 4—Stand-off and feed-through insulators support and rigidize panel wiring. These parts are peculiar to industrial construction and are used most often with high voltage wiring to improve safety.

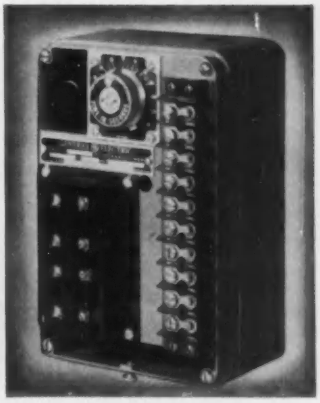


Fig. 5—Electronic Timer, shown with cover removed. The die-cast chassis acts as rear part of enclosing case and front panel. Stamped steel rear panel is not visible in this view. Note rounded corners.

Fig. 6—Pre-cabling a complete wiring harness for a control panel. This practice leads to a considerable saving in production costs, but generally is justifiable economically only when quantities are considerable.

work is clamped and a system for locating the holes on Cartesian co-ordinates provides flexibility. When working from a drawing on which the centers of all holes are located on co-ordinates from one corner of the panel, the turret press operator can quickly set up for each hole, piercing the entire run before setting up for the next hole. On the larger presses of this type, the table movements, turret indexing, and work clamping and releasing are all power operated. The co-ordinates of each hole to be pierced can be set up readily by the use of the indicating scales on the moving table.

Where larger quantities of panels are to be made, multiple progressive piercing has advantages. For this method, a special type of equipment is used. A die set is mounted in the punch press. Templates, to which the proper dies, punches, retainers and strippers are fastened, are bolted to the die set. Thus, a number of holes can be pierced at one blow of the press. Because of the size of the retainers, there are limitations on the closeness of spacing between holes when using this equipment. A number of templates and set-ups (generally not over four or five) may be necessary to complete the piercing. The templates, however, are not very costly, and set-up time is held to a minimum by the use of snap rings to fasten the various retainers, dies, punches, etc. to the templates. Since the units may be dismounted from the templates and used on other jobs, tooling costs are low, consisting only of the cost of templates and whatever punches or dies are not already on hand.

On certain jobs, special piercing dies may be used to pierce all holes in one blow. This may be desirable on small panels where the production is fairly high and no changes in design are contemplated for several years. However, when die life is not an important factor because of the modest total quantity, the less expensive types of dies should be seriously considered.

Enclosing Case Design and Manufacture

Enclosing cases are of two basic types, wall-mounted and floor-mounted. The deciding factor is size and weight. Cases over 48″ high by 30″ wide by 18″ deep approximately, are generally floor-mounted.

The present trend in wall-mounted enclosures is to design with well-rounded corners and edges. This normally can be accomplished by using draw dies to form the parts. However, draw dies are expensive, and for the relatively low quantities involved, are not economically feasible. Where use can be made of an existing drawn shell case, efforts should be made to do so, since this type of case is the least expensive.

The expense of drawing dies and the necessity of having a complete size range of cases has led to the development of fabricated round-cornered cases which, from all outward appearances, are identical with drawn shell cases. The rear of the case is basically a flanged wrap-around, into which a flat back plate is spot welded. Since flanging and bending are all separate operations, the tooling can be used for many different case sizes.

The cover is made from sheet stock sheared into the proper sized blanks. The blanks, which are rectangular, are corner-notched with a specially developed shape for the corner radius desired. Since this shape depends only on the corner radius, the depth of the cover can be varied by controlling the extension of the notch into the corner of the blank. Next, a forming die bends up the sides of the cover and simultaneously forms the round

corners. This leaves a seam in each corner of the cover, which is subsequently filled in by gas-welding and then ground smooth. The forming die is actually built up of separate form blocks for each corner with spacer blocks between them. By using different lengths of spacers, many different sizes of covers can be made. The effect is to provide versatile tooling at a moderate cost.

Occasionally, specifications call for explosion-proof or water-tight enclosures. These enclosures are commonly designed as cast iron cases with machined and bolted flanges. Lately, however, there has been a trend toward heavy fabricated cases having a large surface area of porous metal, such as sintered bronze for explosion-proof applications. When a fire or explosion originates within the case, the resulting gases are cooled while passing through the porous filters and are incapable of igniting the atmosphere surrounding the case. This, of course, is just another method of obtaining the "minimum flame path" for explosion-proof enclosures. The particular advantage is in the lower manufacturing cost of the fabricated case when only a small quantity is to be made.

Methods of Wiring

The type of wiring used in a given design is dependent upon the particular components chosen and the size of the product. Generally, for small products such as photoelectric relays and electronic timers, components with solder tabs are used to conserve space and permit short leads. The resulting wiring is termed "point-to-point." Wires, resistors or capacitors are run directly between components in the shortest path. Because of this, the designer must consider the arrangement of components as they affect the wiring. Proper layout will result in an orderly wiring arrangement which is desirable for both lower cost and increased ease of servicing. It is recommended that the components be placed in such a way that the wiring progresses in an orderly fashion from one circuit function to the next in the same sequence as indicated by the electrical design of the control.

In the larger equipments, the majority of components have screw terminals, since space is not as important a factor as in the small devices. Because of the complexity of these large controls, resistors and capacitors are secured to mounting boards to permit easy identification and replacement by the customer's maintenance personnel. All interconnecting wires are arranged neatly as the wiring progresses and laced together to form cables. Sometimes, instead of lacing, the wires are placed side by side and held to the panel by cleats.

When production of a particular panel is to be repetitive, the wiring for the complete panel may be "pre-cabled." In this method, the wiring is laid out on a full scale drawing of the panel, and from this, a cable drawing is prepared. This drawing is then fastened to a board as in Fig. 6, and headless nails are driven into it at the locations of all terminals. All wires are pre-cut to length, their ends stripped of insulation, and terminals are crimped on. The wires are identified by printing or hot stamping on the insulation at each end. Each wire is placed in position on the board with its terminals on the nail, with the corresponding number. After all wires are in place, the entire assembly is laced together into a single unit and removed from the board. Then, to wire the panel, it is necessary only to place the harness on the panel and connect the wires to the terminals of the various components. Since all the wire terminals automatically line up with their corresponding terminals on the components, there is little chance of error.

When a large variety of controls are being manufactured, it may be possible to take those elements or basic functions which recur in identical or nearly identical form, and convert them into separate sub-assemblies which may then be used with all panels requiring these particular functions. These unit subassemblies, affect an overall cost reduction because of the increased quantity in which they are made.

These are the basic considerations involved in transferring an electronic control from the circuit drawing into an efficient industrial product. Considered as a product, the control must be rugged and reliable; neat in appearance and convenient to use; easily installed and serviced. Perfection in circuit design is wasted unless the standards of product design are correspondingly high.

The era when circuit design was the prime activity in the field of electronics is now apparently over. Spurred by military and industrial demands, components and assembly methods are receiving increasing attention. This trend will benefit all users.

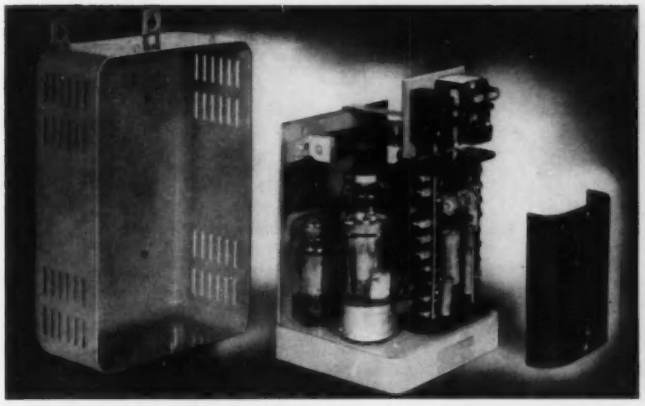


Fig. 7—Electronic assembly incorporating thyratron for motor control. This type construction is called, "design-in-depth" panel to distinguish it from the flat panel construction. Above design is compact, but is more difficult to wire than the flat panel.

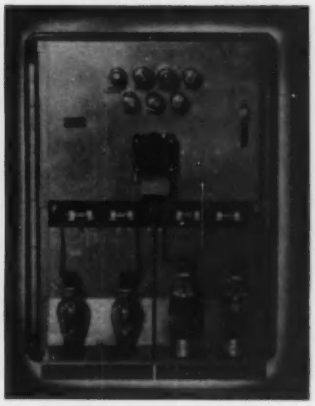
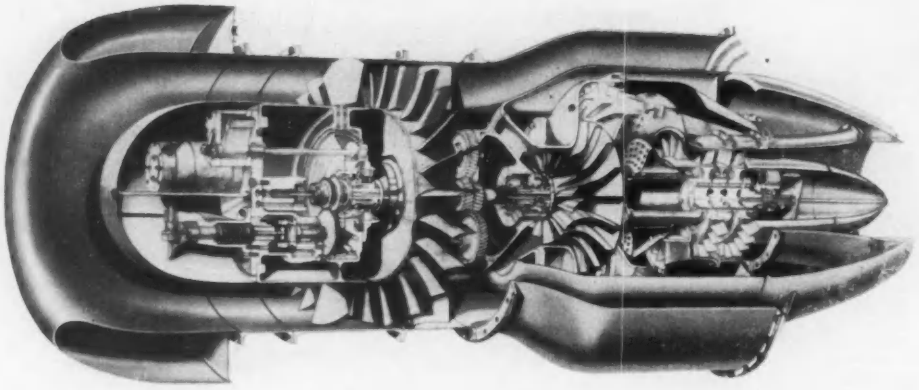


Fig. 8—Hinged-panel simplifies servicing in this motor control. Opening panel makes wiring and components accessible.

TECHNICAL NEWS



U. S. Buys Manufacturing Rights For Nine French Gas Turbine Engines

CONTINENTAL MOTORS CORP. has purchased from Societe Turbomeca, of Bordes, France, exclusive United States manufacturing rights to a family of nine gas turbines developed under sponsorship of the French Air Ministry, spanning a horsepower range from 200 to 1,100, and now ready for production after exhaustive tests in actual use.

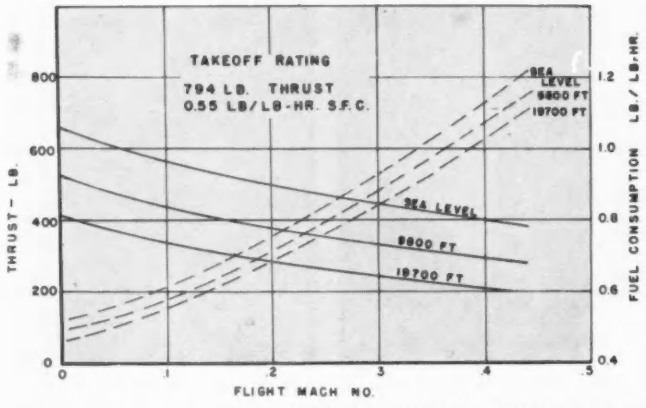
One model, the Aspin ducted fan, when installed in a 4-place aircraft with other characteristics about the same as present airplanes of that type, will make possible a cruising speed of approximately 300 mph compared with about 170 mph at present. The ducted fan turbine operates as a jet, in which air from a fan is ducted aft to a jet discharge.

It is essentially a shaft turbine in which the power is absorbed driving a very high speed multi-blade propeller forming an integral part of the machine. The air moved by this propeller, or fan, is ducted aft to a jet discharge. The characteristics of the machine are intermediate between a shaft turbine and propeller, and a pure turbo-jet. For a given fuel flow the thrust is substantially higher under static conditions than a turbo-jet, but lower than a turbo-prop. On the other hand, at high flight speeds the situation is reversed, with the ducted fan developing more thrust than the turbo-prop and somewhat less than the pure turbo-jet.

Other engines in this transaction include the Artouste I turbine which gives 280 horsepower and weighs only 185 pounds, about one-half as much as a piston engine of comparable output. It will enable a helicopter to carry extra passengers or, as an alternative, to fly faster and reach higher altitudes.

Another of the series, the Palouste turbine, functions as an air compressor which supplies 1,830 cubic feet of free air per minute at 50 pounds per square inch pressure. It can be used for starting large aircraft turbines, for portable heating systems, for jet-type helicopter rotor drives, and for the operation of air power tools such as are used in construction work.

The Palas and Morbore II turbines give jet reaction of 330 pounds and 880 pounds, respectively, with fuel consumption and weight comparable to those of the largest military turbines. They find their special field in aircraft of the 400-to-500 mile per hour class, such as target aircraft to train anti-aircraft crews, and for gunnery practice for aircraft. In addition, these turbines are used as boosters for assisting on take-off and climb after take-off on bombers and passenger planes where extra load is required, or where take-off is from landing fields that are located at high altitudes.



CUTAWAY DRAWING (ABOVE) AND PERFORMANCE CURVES for the Aspin Ducted Fan Engine, which will be manufactured in this country under French license.

Miniature Electronic Units For Jet Trainers Provide Higher Efficiency and More Power

SIX MINIATURIZED UNITS will be used on the new USAF B-47B flight simulator, the F-89, and succeeding models. The new units, which are smaller and cheaper, include a servo amplifier, summing amplifier, linear phase detector, variable frequency oscillator, audio amplifier, and phase detector. They were developed by Link Aviation Inc., Binghamton, New York.

Conservation of space was only one of the factors involved in the development of these miniaturized units. Undistorted signal reproduction, accuracy of computation and control, and unit interchangeability with no adjustment were primary considerations of the Link engineers who designed them.

The new units have a vastly improved performance over the old ones. They have greater accuracy and stability, and can be used much more indiscriminately than the larger and more expensive ones. Productionwise, they are easier to produce and therefore cheaper. Components are assembled on strips as basic assemblies. Leads have been shortened and wiring of the chassis is limited almost entirely to tube filaments.

Inspection and maintenance procedures are likewise affected. Production testing and adjusting require minimum technical skills. Units are tested against specified meter indications and for the most part adjustments are unnecessary. Servo units are pre-adjusted before installation.

Adjustments formerly made against whole trainer systems are now made against fixed standards. Knobs and adjustable potentiometers are virtually eliminated. And, the servicemen can carry several units in a small service kit for replacement or exchange on the job.

A common power supply is also being incorporated in the B-47B jet flight trainer along with the miniature electronic units. The single power package consisting of a 12 hp motor and two generators supplies constant high (300) and low (28) voltages for all trainer systems. Besides furnishing the new components with the high quality power source they require, the common power plant eliminates the multiplicity of individual power supplies with their attendant complexities, excessive costs and wasted space.

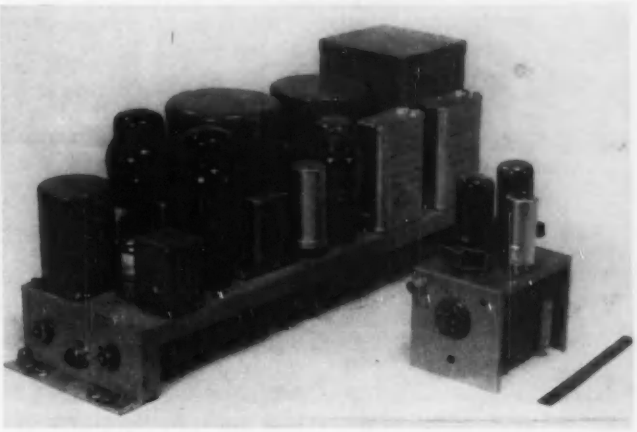
The servo amplifier was the first miniature unit to be developed. Its chassis has been adopted as the physical size for the others. It is designed to fit across a standard $5\frac{3}{8}$ x 19 in. half chassis for in-line mounting on the servo or computer with which it is used. Miniature tubes and components are used as much as possible to conserve space.

In spite of its compactness and small size, the unit provides more efficiency and more power without sacrificing reliability than the larger amplifiers formerly used. Purpose of the servo amplifier is to control the directional rotation of the electric servo motor. Direction of rotation of the motor depends on the phase characteristics exhibited by the miniature amplifier input signal or signals.

The summing amplifier was developed to replace the old variable gain and summing amplifiers. Comparable to the new servo amplifier in size, the summing amplifier serves a multiple purpose in the system functions of the trainer. It adds multiple input signals and produces an output proportional to the sum of the inputs. The input to the summing amplifier is very high impedance; the output impedance is very low. Therefore, the amplifier may be used as an isolation stage without fear of loading problems which might otherwise exist. The input signal may also be amplified as much as 100 times without distorting the output signal.

Function of the linear phase detector is to provide a d-c output signal directly proportional to the magnitude of an a-c input signal. Polarity of d-c output voltage is determined by the phase of the input signal. A specific application of the linear phase detector in the trainer is found in the instrument landing system where d-c meter movements are actuated by linear phase detector output current.

Designed to furnish in a small package the various frequencies required in radio aids simulation, the variable frequency oscillator gives stable oscillator performance with an adjustable frequency range that extends from 200 up to 4,000 cycles.



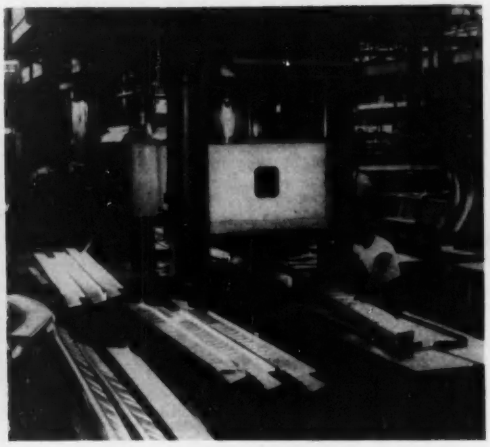
MINIATURE SERVO AMPLIFIER (right) is only one-sixth the size of the superseded unit. It has equivalent power output and twelve times the gain.

Cathodic Protection Saves Critical Metal

TO REDUCE REPLACEMENT COSTS on electric cables, tanks, pipes and other metallic structures, the Navy Department has stepped up its program on cathodic protection. This method, which has been used on a limited scale by the oil and natural gas line operators, prevents galvanic and electrolytic deterioration by providing a source of direct current at one or more strategic points, from which the current constantly flows toward the structure that is being protected.

The most successful power supply components found to date are metallic rectifiers and metallic anodes. Copper oxide or selenium is used for the rectifiers and high quality magnesium is considered best suited as the anode material since it is electro-chemically positive material. The anodes are buried in the earth or suspended in a tank filled with liquid, or in the ocean to control the galvanic activity.

PORTABLE TELETYPEWRITER developed by Army Signal Corps and Kleinschmidt Labs can transmit and receive 100 words per min and weighs only 116 pounds. It replaces slower equipment that weighed over 400 pounds. All components are compact, rugged and waterproof. The assembly can be installed and put in operation in the field by one man in 10 min.



CLAD ALUMINUM ALLOY is formed into Z-sections by 1,500 ton hydropress at Ryan Aeronautical Company. Sections will be heat treated in a molten salt bath and spot welded to form floor beams for C-97 strato freighter.

Great care is used in cleaning before spotwelding. Small particle of foreign matter can ruin a spotweld.

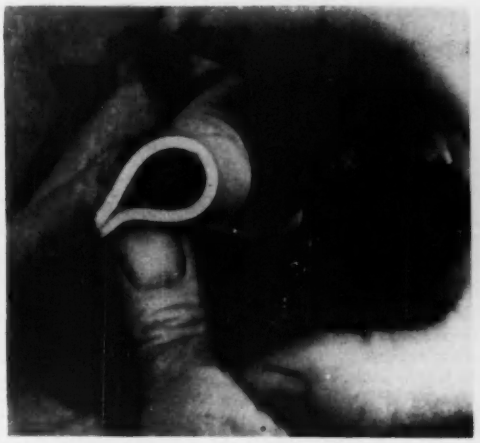
ALTERNATE FOR CHROME PLATE still bright after 10,000 miles of driving through severe types of weather and terrain. Test was conducted by Allied Research Products, Inc. to provide data on experimental zinc plate and Iridite finishing system for bumper guards, gas tank flap, fender skirts, door handles, etc. Some parts are steel base metal; others are zinc die cast base metal. Interior as well as exterior parts were tested.

MODIFIED KODAK HIGH SPEED CAMERA permits both the mechanical and electrical aspects of a subject to be recorded simultaneously on the same film. The modification, announced by the Eastman Kodak Company, consists of the addition of a second lens to the camera to record the images on the tube of a cathode ray oscillograph through the back of the film, while the mechanical aspects are being photographed on the front.

GLASS can now be soldered to metal in a process which makes a bond stronger than the glass itself. The method, which can also be used to solder metal to ceramics and carbon, was originated by scientists of the G-E Research Laboratory, and is being tested for industrial applications. The glass and metal areas to be soldered are painted with a thin layer of titanium hydride, and solder is placed upon both painted areas. The parts are placed together and then heated under a vacuum. When the temperature reaches about 900 F, the titanium hydride decomposes. This causes the solder to adhere to the titanium-painted areas of both glass and metal. A strong, tight bond is formed upon cooling. By using soft metal solders that can absorb movement, it is possible to subject this glass-to-metal seal to rapid temperature changes without danger of cracking, despite the wide difference in temperature expansions between glass and metal.

•

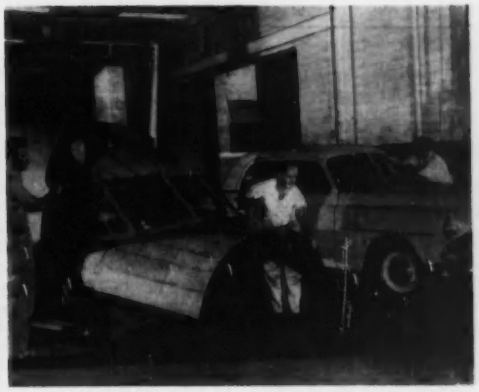
AFTER FIVE YEARS OF DISTRIBUTING, the Atomic Energy Commission an-



SILICONE (WHITE) is soft and flexible after 90 days of aging at 300 F but high grade synthetic rubber is brittle after 3 days. Because of its thermal characteristics plus its ability to be extruded, laminated, calendered and sheeted, silicone is now being fabricated into seals, gaskets, diaphragms and other similar parts and accessories by the H. O. Canfield Company.

A MIRROR-SMOOTH FINISH is put on the rotating element of General Electric's hydro-generator thrust bearing. Bearing supports a load of almost 2,000,000 pounds, including the weight of all rotating parts of the generator and hydraulic turbine plus the thrust of the turbine. Bearing is now installed in a 82,500 KVA, 180 rpm hydro-generator in the Southwest.

SIXTY THOUSAND TINY STEEL BALLS destined to become the points of ball point pens, are being checked for surface defects at SKF Industries, Inc. by an inspector wearing a "Magni-Focuser", a special magnifying glass that is manufactured by Edroy Products Company. With this magnifying device, the inspector can almost look around the balls, leaving both hands completely available for her work.

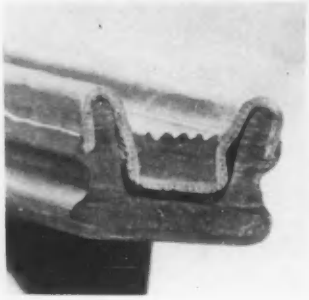


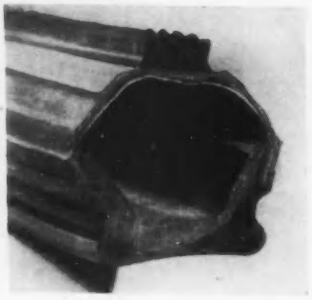
DEFENSE WORK BLENDS WITH CIVILIAN PRODUCTION at the Plymouth Division, Chrysler Corporation. While production of passenger cars continues at the plant, assembly operations have started on the company's defense assignment to build hulls for the Grumman Albatross air rescue plane. Here workers move completed cabin section of plane to final assembly as car made in same plant receives final inspection.

nounced that it has made over 18,900 shipments of radioactive isotopes and 1,550 shipments of stable isotopes for studies in 1,165 departments in some 610 U. S. institutions. In addition, more than 1,135 shipments of radioisotopes have gone to some 250 institutions in 30 nations abroad, and approximately 4,350 shipments have been earmarked for the AEC's own research activities. These atomic energy by-products are contributing important benefits to medicine and agriculture and to the biological and physical sciences, as well as to industry.

•

A NEW COLD ROLL MILL recently installed at the Naval Ordnance Lab., White Oaks, Md., will soon commence producing super-fine steel tape for use in pulse transformers, magnetic amplifiers, guided missiles and other HF applications. The sendzimir mill will take steel strips 0.025 in. in thickness, roll them through oil-filled chambers where thickness is reduced to 0.0005 in.; strips can be produced in widths up to 8.5 in. The machine weighs 6,000 lb.; is powered by five motors.





INFLATABLE STRIP SEAL for high altitude flight-pressurizing of the bubble-type canopy for military aircraft has been developed by the B. F. Goodrich Company. It prevents high altitude blowouts and yet, when inflated, exerts a minimum separating force between canopy and fuselage. Special rubber-coated textile fabric is vulcanized in collapsed position to a flexible rubber channel-type base. Inflated, the rubberized fabric lifts to its maximum sealing position with little or no stretching of the rubber. Sealing is practically instantaneous, with only a few pounds of pressure above that inside the canopy required. Deflation is just as easy.

Designs of the seal vary with each airplane model and type. Its high lift ratio provides clearance in the deflated position and easy adjustment of the canopy without sliding and scuffling damage to the seal. Other uses include applications as weather seals between fuselages and detachable cargo structures of transport aircraft, and as water seals in amphibious vehicles.

Titanium May Be Produced At 20 Percent of Present Cost

THE COST OF TITANIUM may be reduced from $5 to $1 a pound as a result of a new production process developed by Horizons Titanium Corp. under contract with the Office of Naval Research.

Although details of the process are not available, it is known that pilot-plant stages in production have been reached. Perhaps an indication of what will develop is that Dr. Irwin R. Kramer, chief of the metallurgy branch of ONR, is now leaving his present position to join Horizons as assistant to the president.

Cold Extrusion Of Steel Bar Stock

A NEW METHOD FOR COLD EXTRUDING STEEL, called "Koldflo", can be used to form commercial products, according to Mullins Manufacturing Corporation.

The Koldflo Process, according to Mullins' announcement has the ability to extrude commercially on available presses and in combination with other press operations such as drawing, ironing, coining and forging. It does not require special surface lubrication and the pressures required to make a steel bar flow in the cold state are surprisingly low.

Engineers who have worked on the process revealed that they can control the flow of steel under pressure so as to direct it where they want it to go with a minimum of internal and external friction. The ability to do this, they say, disproves the popular concept that tremendous pressures and huge presses are required to do such work. Actually, abundant press equipment exists which can be used to cold extrude steel by the Koldflo Process.

The company first announced its work in the cold extrusion field when it revealed last year that it had developed a successful method for cold extruding 105 mm. shells for the Ordnance Department who recognized the possibility and the need for such a process. The Koldflo Process goes far beyond the cold extrusion process used for making shells, which deals with heavy-walled, cylindrical shapes. Now the process can be applied to shapes represented by such objects as thin-walled pressure cylinders, shock absorber cylinders, gear blanks, pulley hubs, bearing housings, and hub and axle components for vehicles.

Substantial cost savings are indicated on those parts which can be made by it, as well as superior products. For example, scrap is virtually eliminated, as only enough metal to make the part is cut from a solid bar. Stamping, forging or machining cylindrical objects from flat blanks or from rounds of necessity wastes from one-fourth to one-third of the original steel. In the making of artillery shells, Army Ordnance has estimated that if all the 105mm, shells made during World War II had been made by the cold extrusion process, a million tons of steel would not have been reduced to scrap.

The process is so exact that weight and size tolerances can be held within the limits required for most mass-produced, precision parts. Parts are produced with glass-smooth surfaces. This means that many products would not require any expensive finish-machining. Other economies would come from the elimination of man hours and the savings in machinery and plant space over other methods of forming metal.

Another advantage of the process is that it creates a stronger steel through cold working the metal. It can coin, extrude forward and backward, compress, expand and iron. With some products this could mean the elimination of heat treating operations and it could mean the use of steel containing less of such alloys as manganese, chrome, and nickel.

Mullins has granted several licenses under which one company already is tooling to produce a pressure cylinder. Additional licenses are being negotiated.

Interest in cold extrusion of steel received considerable impetus after World War II when it was discovered that the Germans were using such a process in a limited way. A drawback to the German technique was that it required extremely large presses, some of them exerting pressures up to 30,000 tons, and it used an elaborate method of lubricating the metal before it was extruded.

Electrostatic Forces Apply Paint in New Process

A NEW PAINT SPRAYING PROCESS developed by the Ransburg Electro-Coating Corp. uses electrostatic atomization instead of compressed air to apply the coating. In this process, the article to be coated is carried by a conveyor past a new type spray "gun," that consists essentially of a hollow, cone-shaped head. Coating material is metered at a constant rate to the apex of the head, and rotation of the head spreads the material uniformly

over its inner surface, causing the material to flow evenly to the outer edge.

A source of electrostatic high potential, having one terminal grounded and its other terminal connected to the head, creates a strong electrostatic field between the head and the article to be coated, which is grounded by the conveyor. The force of this field transforms the material into a spray of fine, charged particles and creates an irresistible attraction that pulls the spray particles to the grounded article. This accounts for complete electrostatic deposition.

Major variables, such as atomization air pressure, spray pattern, fluid delivery, and overspray exhaust air currents have been eliminated. Thus, all dependence of spray painting upon the art and skill of the operator and the hand spray man is removed. It permits positive duplication of results, and its ease of setup and operation makes it truly "push-button" painting.

All of the paint leaving the spray head is deposited, and there is no overspray to be exhausted. No water-washed walls for collection or removal of wasted paint are necessary. No compressed air is used in the entire system; so the waste of paint inherent with the use of air atomization, as in the ordinary spray gun, does not exist. Ventilation of the area for control of solvent vapor is all that is required.

Any material that can be readily atomized can be applied by this process.

New Midget Magnets Are Powerful But Costly

A COBALT-PLATINUM MAGNET, which in small sizes is described as the world's most powerful permanent magnet, has been developed by the General Electric Research Laboratory.

Present commercial use of the new magnet will be limited, however, not only by government restrictions on the use of cobalt, but also by prohibitive expense of the large amounts of platinum used in the alloy.

The new magnet will not replace presently used magnetic alloys, such as the Carboloy Alnico magnets, but is intended for new fields of use for which existing magnets are not suitable.

Compared with Alnico-5 magnets, generally rated as the most powerful in commercial use, the new magnet is less powerful in large sizes but more powerful in small sizes.

Other advantages of the new magnet are its ductility, or ability to be drawn into wire or thin sheets, and its comparative ease of machining.

Cheaper Germanium Crystal Cuts Cost of Rectifier

REPLACING VACUUM TUBES in radio receivers with germanium rectifiers and amplifiers is promised with cheaper germanium crystals produced by a process on which a patent has been issued with the patent rights assigned to Sylvania Electric Products, Incorporated.

The process uses a less pure germanium metal as a starting material and thereby greatly reduces the cost of manufacturing. The inventor claims the process results in a germanium crystal with improved electrical characteristics.

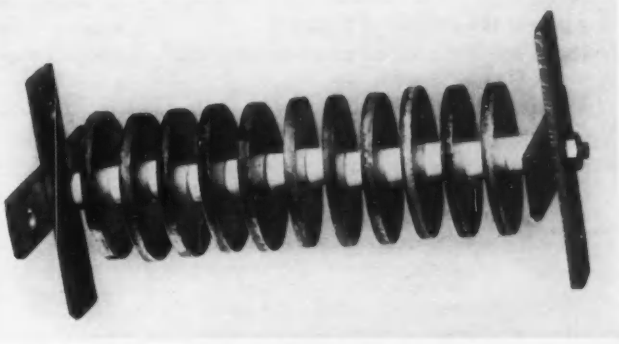
The new crystals are made by reducing germanium dioxide in powder form in an atmosphere of hydrogen at a temperature of 700 degrees Centigrade. Then one percent of metallic tin is added, and one-tenth of one percent of additional germanium dioxide. The mixture is heated in a furnace to a temperature of approximately 1,000 degrees.

Research Engineers Study High Temperature Corrosion

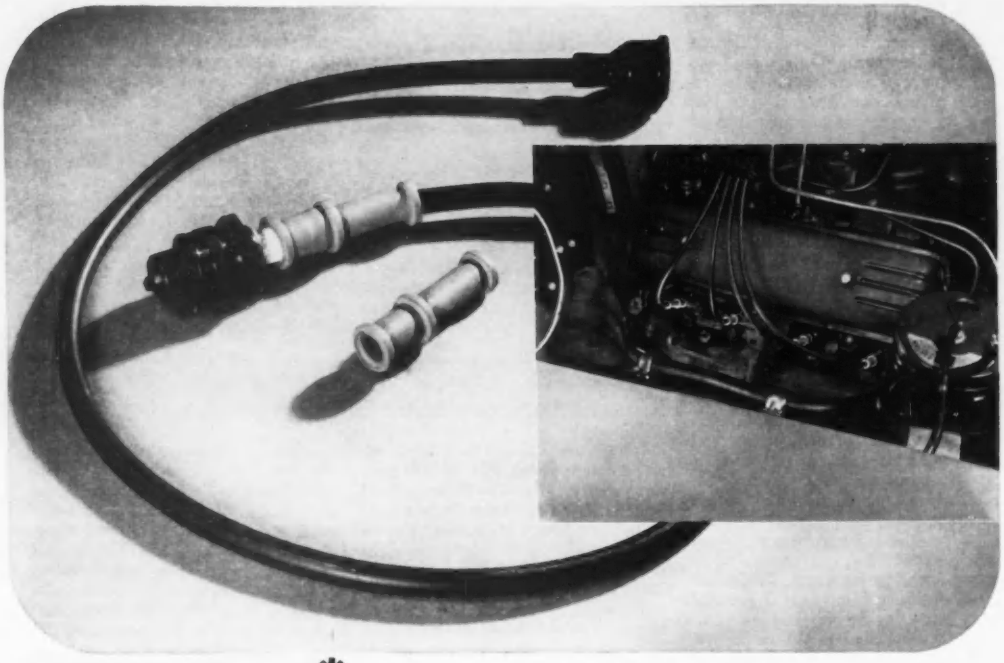
DATA ON THE CORROSIVE EFFECTS OF various hot environments have been accumulated by the Development and Research Division of the International Nickel Company, Inc., according to an announcement by T. H. Wickenden, vice president in charge of the Division. This has involved a continuing and expanding program designed to evaluate the corrosion resistance at high temperature of different metals and alloys for such specific applications as are encountered in the aviation, petroleum, chemical processing, heat treating, and other fields, especially those producing equipment and supplies for the defense program.

"There is still a great deal to be learned about high-temperature corrosion, not only with respect to some of the underlying principles governing surface reactions, but also from the practical aspect as to means of eliminating or minimizing corrosion damage by selection of appropriate alloys," Mr. Wickenden said. He pointed out that a large amount of data on the creep and rupture characteristics of materials at temperatures up to and including 1800 F and some data at temperature as high as 2100 F has been secured in the Company's Laboratories at Bayonne, N. J. and Huntington, West Va. In addition test spools, or racks, have been installed under actual operating conditions in industry. Each of these spools contains specimens of a variety of alloys and a comparison of their performance is made at frequent periods of time.

While strength characteristics are unquestionably important, he emphasized that to achieve long life and trouble-free service in high-temperature environments it is usually necessary to place governing importance on the corrosion behavior. This fact has been further confirmed by information on high temperature corrosion mechanisms studied at the Bayonne and Huntington Laboratories and by engineers of the Development and Research Division. Information already secured has been made available and additional data will be provided as developed.



SPOOL USED FOR TESTING SAMPLES of different metals and alloys under actual operating conditions in high temperature corrosion study.



SILASTIC* boots plug ignition leaks!

It's no longer a trade-secret that some of the leading automobile manufacturers are using Silastic boots to plug ignition leaks. Molded of Silastic 250, these spark plug boots exclude moisture; remain flexible for an indefinitely long period of time at sub-zero temperatures and at operating temperatures in the range of 400° - 450°F. They withstand hot oil and they keep a spark at 27,000 to 40,000 volts from jumping over the outside of the plug.

These are the properties of Silastic that make engines easy to start even on a wet morning. And these are the properties that start engineers to work simplifying the design and increasing the service life of hot air shut-off valves, transmission systems, cooling fins on aircraft engines, anti-icing systems, traction motors, transformers and cable. You can do extraordinary things with Silastic, the Dow Corning silicone rubber that retains its properties over a temperature span of more than 600 degrees from —100° to +500°F.

*T. M. REG. U. S. PAT. OFF.

Please return this coupon

to DOW CORNING CORPORATION, MIDLAND, MICHIGAN

Please send me
- ☐ Silastic Facts No. 10 on properties and applications. R-11A
- ☐ Silastic Fabricators for sources of supply. R-11B

Name_____

Title or Dept._____

Company_____

Address_____

City_____ Zone_____ State_____

FIRST IN SILICONES

DOW CORNING CORPORATION

MIDLAND, MICHIGAN

ATLANTA • CHICAGO • CLEVELAND • DALLAS • LOS ANGELES • NEW YORK • WASHINGTON, D. C.

In CANADA: Fiberglas Canada, Ltd., Toronto • In GREAT BRITAIN: Midland Silicones, Ltd., London

Selection Chart for Investment Casting Alloys

D. V. LUDWIG, Consultant and R. L. WOOD, Arwood Precision Casting Corp.

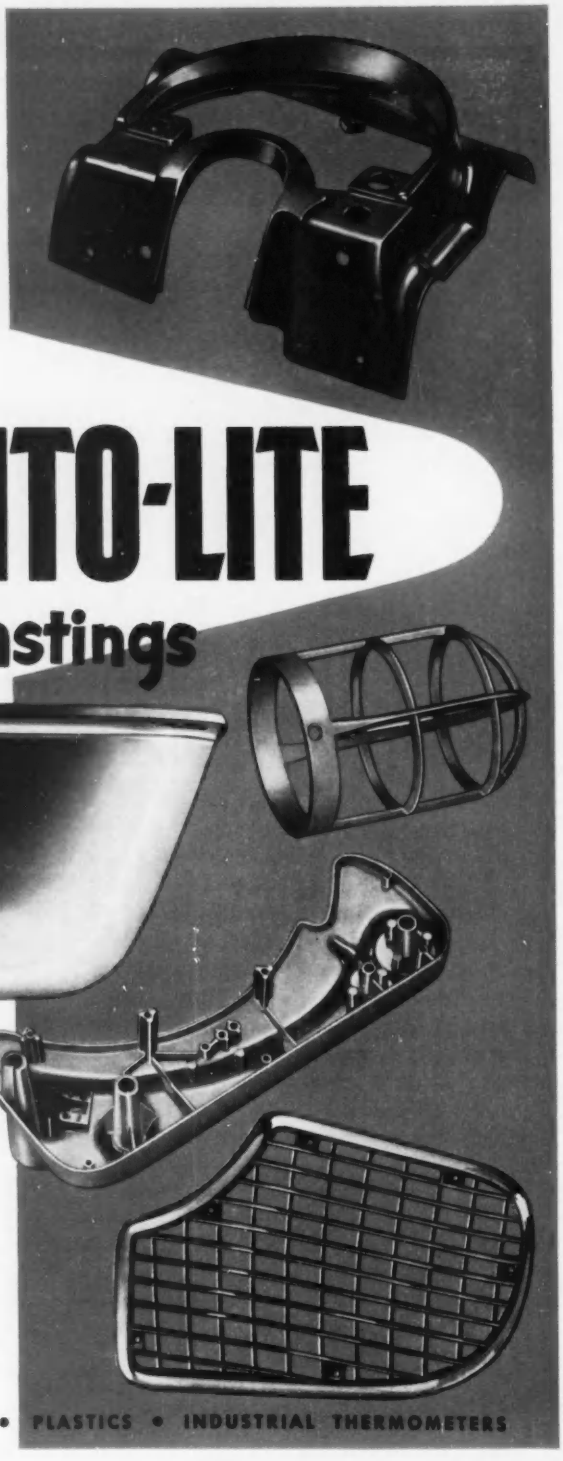
Alloy	Tensile* Strength Psi, Avg.	Rockwell Hardness	Castability Rating	Special Properties	Applications	Design Recommendations
LIGHT METALS						
Alcoa 356 Alcoa *T6*	21,000 36,000	E 65 F 75	Recom.	Most useful light alloy; combines best foundry properties with best overall mechanical properties.	For instrument and light structural parts.	Maximum fluidity permits 0.030″ walls, 0.020″ holes in light sections, fine serrations, most intricate cored parts.
Alcoa 43	23,000	F 70	Good	Slightly better corrosion resistance than other light alloys.	Used for unstressed instrument parts requiring maximum corrosion resistance.	
Dowmetal C H. T. & aged	21,000 36,000	E 60 F 80	Good	Lightest structural casting alloy; relatively poor corrosion resistance compared to aluminum alloys.	Applied to aircraft instrument and similar parts requiring maximum strength to weight ratio. It is not pressure tight nor suited for shock resistance.	Minimum walls are 0.030″ for small areas and holes are 0.020″ dia. min. Not good for serrations or stressed parts.
Aluminum 40E	33,000	F 80	Fair	Self hardening alloy, eliminates heat treatment, but most stable when stress annealed; not as corrosion resistant as 356 or 43.	For instrument and structural parts subject to moderate stress and limited impact. It has greatest dimensional stability.	Walls under 0.050″ not pressure tight; not good for stressed serrations or similar fine details.
COPPER BASE ALLOYS						
Silicon-Brass	48,000	F 80	Recom.	Best general copper base casting alloy; high corrosion resistance, good impact resistance, high fluidity; best chemical stability.	Used in the majority of industrial equipment components; brackets, cases, gears, etc. Best for complex, thin sectioned and long castings.	Minimum wall for extended areas is 0.030″; minimum holes are 0.020 in. sections 0.030″ thick. Good for fine raised letters, serrations, threads, etc.
Red Brass (85-5-5-5)	36,000	F 70	Good	Best hydraulic casting alloy; good sleeve bearing properties. Possesses the best machinability.	For pressure-tight castings; also for intricate, moderately stressed parts incorporating very fine holes.	Threads and details can be easily machined. Minimum wall for pressures is 0.050 in.; smallest holes are 0.030 in.; thinnest edges are 0.010 in.
Phosphor-Bronze	47,000	F 80	Good	Best electrical properties with 80 percent relative conductivity. It is a good bearing alloy with superior corrosion resistance.	Second choice for moderately stressed general structural parts.	Not recommended for fine details, thin walls or fine holes.
Beryllium-Copper	77,000 176,000	F 100 C 40	Good	The only heat treatable copper base alloy which can be brought to good spring temper. One difficulty is to control the uniformity.	Used for small, intricately designed springs; gears not subject to impact. Good abrasion resistance when hardened; poor impact strength.	Minimum wall thickness is 0.030 in. over limited areas, 0.050 in. is better; minimum hole is 0.020 in. and minimum edges are 0.020 in.
Manganese-Bronze	77,000	F 95	Fair	Has maximum strength with good impact resistance; maximum corrosion resistance to salt water; good strength at temperatures up to 1000 F.	Not recommended when silicon brass can be used. This metal has poor fluidity and not good for fine detail.	The minimum pressure-tight wall is 0.060 in. but this metal is not recommended for high pressures. Smallest holes are 0.030 in.
Aluminum-Bronze	50,000 82,000	F 80 B 90	Fair	Alloy is best for abrasion resistance. Better than other copper-base alloys for high temperature use up to 1250 F. Very good resistance to many chemicals, acids, etc.	Used only for gears or parts requiring good abrasion resistance and high impact strength; not recommended for intricate, fine detail, due to high drossing tendency.	On well tapered simple sections the minimum edge is 0.015, minimum holes are 0.030; while pressure tight wall thickness is 0.050.
Nickel-Silver	35,000	F 90	Fair	Chiefly used for ornamental purposes, musical instruments, etc. Possesses good corrosion resistance to atmosphere.	Not recommended for stressed parts or for extended wall areas requiring high surface cleanliness.	Minimum edges are 0.010 in. on tapered sections; smallest holes possible are 0.030 in.

In each group, the first alloy listed is generally the best from a casting standpoint and is recommended wherever possible.

* When two values are given: the upper value represents the as-cast and annealed condition; the lower value is the maximum that can be obtained by heat-treatment.

(Continued on page 205)

You're always right with AUTO-LITE Die Castings



● Many of America's leading manufacturers, producing a wide variety of products, are benefiting from Auto-Lite die cast research, experience and advancement. Such developments as high pressure casting, special alloying practices and improved quality through the "controlled metals process" make Auto-Lite the logical source of supply for precision die castings. Address inquiries to:

THE ELECTRIC AUTO-LITE COMPANY
Die Casting Division
Woodstock, Illinois
Lockland Division, Cincinnati 15, Ohio

600 So. Michigan Ave.
Chicago 5, Illinois

723 New Center Bldg.
Detroit 2, Michigan

Tune in "Suspense!"....CBS Radio Monday....CBS Television Tues.

DIE CASTINGS • WIRE & CABLE • PLASTICS • INDUSTRIAL THERMOMETERS

Selection Chart for Investment Casting Alloys (continued)

Alloy	Tensile* Strength Psi., Avg.	Rockwell Hardness	Castability Rating	Special Properties	Applications	Design Recommendations
LOW CARBON AND LOW ALLOY FERROUS ALLOYS						
SAE 4130	75,000 175,000	B 90 C 45	Good	Has good carburizing properties, and moderate grain size.	Used for moderately stressed parts. Maximum uniformity of properties of all low alloy steels when suitably heat treated.	It is a recommended substitute for SAE 1020, 1030 or 3120. Minimum wall of 0.050 in.; minimum holes are 0.050 in. and minimum edge radius, (on tapered sections) is 0.012 in.
SAE 4140	110,000 200,000	C 24 C 55	Good	Higher strength than 4130 but lower impact resistance. Available in wide range of heat treated conditions. Can be case carburized readily; however it is susceptible to surface decarburization.	Recommended substitute for all other 0.40% carbon steels such as SAE 1040, 3140, 4640, 6140, 8640.	Still machinable when hardened to 440 BHN due to Molybdenum. It has the same castability as 4130. Best machinability when heat treated to 200–280 BHN.
SAE 3120	75,000 105,000	B 75 B 90	Fair	Easily case carburized with moderate physical properties. It is a substitute for SAE 1020.	Used for simple structural parts not subject to high stress or impact.	Not good for fine detail; the minimum edges are 0.025 in. and minimum wall thickness is 0.060 in.
Nitralloy 135	95,000	B 95	Fair	Readily case hardened by nitriding. It has maximum wear resistance with good impact strength and corrosion resistance. Fine grain size.	Used for journals, gears, sprockets and similar applications requiring maximum wear resistance.	Not as castable as 4140. The minimum edge radius is 0.020 in.; the smallest hole is 0.050 in. and minimum wall is 0.050 in.
HIGH TEMPERATURE ALLOYS						
Vitallium: HS 21; AMS 5385 HS 23; AMS 5375 HS 27; AMS 5378 HS 31; AMS 5382 S 816	59,000 58,000 51,000 61,000 78,000	A 65 A 65 A 61 A 60 C 26	Recom.	The cobalt base alloys are as castable as the austenitic stainless steels. These alloys can sustain appreciable static and dynamic stresses above 1200–1500 F. Cobalt alloys have been used up to 2000 F. In the resistance to erosion or corrosion, these alloys compare with the higher temperature grades of stainless.	Widely used in extreme service parts for oil, mining and chemical industries; also in turbine blade applications.	Specific differences between the cobalt alloys must be obtained from the foundry. The useful minimum castable details are: edges 0.015; holes 0.050"; walls 0.050". Cast threads to class 1 fit are only threads possible, as these alloys are unmachinable.
Inconel	45,000	B 87	Recom.	Possesses superior electro-magnetic properties, comparable to pure nickel in cast form.	Used for electronic equipment parts as an alternative for pure nickel.	Not suited to very fine detail; minimum useful edge radius is 0.016 in.
Hastelloy A B	52,000 58,000	B 90 B 95	Recom.	Outstanding chemical resistance to hot HCl, H_2SO_4, wet Cl_2 and most organics; good mechanical properties at temperatures above 1500 F; exceptional abrasion and erosion resistance. Has exceptional "as-cast" hardness.	Recommended for applications in oil producing equipment, mining drill and excavating machinery parts where wear and chemical erosion resistance is important.	Can be cast to fine detail, but low ductility limits its use for intricate parts subject to impact.
Monel Monel H Monel S	82,000 105,000 130,000	B 75 B 95 C 37	Good	Has good corrosion resistance; good electrical and magnetic properties.	Primarily developed for food process equipment, it has wide use in chemical industries.	Not as castable as austenitic stainless, fairly intricate details are producible; thin sections are not readily cast; Monel S has low impact resistance.

In each group, the first alloy listed is generally the best from a casting standpoint and is recommended wherever possible.

* When two values are given: the upper value represents the as-cast and annealed condition; the lower value is the maximum that can be obtained by heat-treatment.

(Continued on page 207)

Can Type 430 Substitute for Type 302?

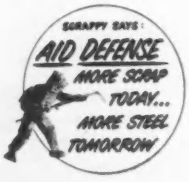
Government restrictions are taking the popular 18-8 chromium-nickel stainless steels "out of the game" for many non-defense uses.

In selecting an alternate stainless steel for their products, many designers have turned to Armco 17 (Type 430)—a chromium grade.

To help you determine whether or not Type 430 is suitable for your products, we have just published a new folder listing satisfactory and unsatisfactory uses. Ask your nearest Armco Distributor to send you this folder.

In fabrication, Type 430 is not as ductile as Type 302. However, with slight changes in practice, many difficult forming and drawing operations can be performed on the chromium grade. Where welding is involved, Armco Type 430 Ti (a titanium modification) provides much more ductile welds than regular Type 430.

These and other fabricating problems are covered in detail in another new Armco bulletin, "How to Fabricate Type 430 Stainless Steel." Your nearby Armco Distributor will be glad to give you a copy.



ARMCO STEEL CORPORATION

4671 CURTIS STREET, MIDDLETOWN, OHIO • PLANTS AND SALES OFFICES FROM COAST TO COAST • EXPORT: THE ARMCO INTERNATIONAL CORPORATION

Selection Chart for Investment Casting Alloys (continued)

Alloy	Tensile* Strength Psi., Avg.	Rockwell Hardness	Castability Rating	Special Properties	Applications	Design Recommendations
FERROUS TOOL STEELS						
Carpenter 610	—	C 63	Good	Air hardening steel with moderate corrosion resistance; it has better wear and impact resistance than stainless 440 F.	Used where corrosion resistance is requisite. A substitute for SAE 1095 tool steel or 440 F for impact resistance.	Minimum useful edge radius is 0.015 in.—not good for thin walls or fine projecting details.
Ketos	—	C 65	Good	Oil-hardening steel with maximum dimensional stability when heat treated to full hardness.	Used for cast tools involving contours which cannot be finished and must be held to close tolerance when hardened.	Not as castable as 52100; minimum useful edge radius is 0.020 in. and is not recommended for thin walls.
Stainless 440 C or F	—	C 62	Good	In the heat treated condition, it is less corrosion resistance than type 420. It is inherently brittle. It can be machined when annealed.	Used for tools requiring corrosion resistance; it is an alternate for 1095 carbon steel and a substitute for 410 or 416 stainless for parts not requiring ductility but needing hardness for wear resistance.	It is as fluid as 52100 but the minimum useful radius is 0.025 in. because of its brittleness. Poor impact resistance at all hardness levels above 45 R. C.
SAE 52100	—	C 30 to 67	Fair	Good- low alloy ferrous alloy: has finest inherent grain size (when Vanadium modified), is least susceptible to deep surface decarburization. Readily case carburized or nitrided to highest hardness.	Moderate structural carburized to C 65 or nitrided to C 67, has minimum spalling tendency.	Recommended for fine detail; minimum edges are 0.012 in. and minimum walls are 0.045 in. Not suited for tools subject to impact.
STAINLESS STEELS						
Stainless Types 302, 303, 304	75,000	B 80	Recom.	Essentially identical in investment cast form. L type 302 should be specified for most applications. Corrosion resistance good to 1500 F continuous service.	Used for all structural castings requiring high impact resistance; often the cheapest substitute for SAE 1020 or 3120 because of superior foundry properties.	Recommended for most intricate designs with a minimum edge radius of 0.012 in. and minimum walls of 0.045 in. Fine projecting details, some serrations and thread designs may be cast.
Stainless, Types 309, 310, 312, 330	75,000 63,000 90,000 70,000	B 80 — B 92 B 90	Recom.	Alloys have better corrosion resistance at high temperatures as their alloy content increases. All suited for continuous service in air at 2000 F and in oxidizing, sulphurous gases at 1900 F. Type 330 not good for reducing atmospheres at 1800 F; however the others are.	Type 309 is widely used for intricate aircraft turbine stator parts; type 310 is somewhat stronger above 1500 F; 312 is particularly resistant to oxidizing hot acids and 330 is resistant to carburizing gases and chemicals.	All alloys are as fluid as type 302 and reproduce the finest details.
Stainless Type 316	86,000	B 82	Recom.	Particularly resistant to intergranular attack when used in the range of 800–1400 F (because of 2.5% Mo.).	Recommended for high temperature steam turbine blades and for castings contacting hot sulphurous exhaust gases up to 1900 F.	Equally castable as type 302.
Stainless Types 321, 347	80,000	B 80	Good	The use of Ti and Cb as suppressants of intergranular attack in critical range 800–1400 F is questionable.	Used for general structural parts not requiring high strength. Corrosion resistance at elevated temperatures is similar to type 302.	Best to use type 304 in place of these modified types unless a definite advantage exists.
Armco 17-4 PH	90,000 170,000	B 90 C 45	Good	The only chrome-copper precipitation hardening stainless alloy. Possesses most properties of austenitic stainless, except that it is magnetic.	Used for structural castings requiring good corrosion resistance and high strength.	Preferred as a substitute for 410 or 416 stainless as well as 420, 1020, and 3120. Good fluidity gives good detail reproduction; min. edges of 0.015 in. and min. wall thickness of 0.050 in.
Stainless Type 420	100,000 180,000	B 80 C 50	Fair	Moderately corrosion resistant; inherently brittle at sub-zero temperatures.	For hardenable low-stressed structural parts.	Use in place of 410 or 416. Min. edges are 0.020 in. Not good for projecting details.

In each group, the first alloy listed is generally the best from a casting standpoint and is recommended wherever possible.

* When two values are given: the upper value represents the as-cast and annealed condition; the lower value is the maximum that can be obtained by heat-treatment.

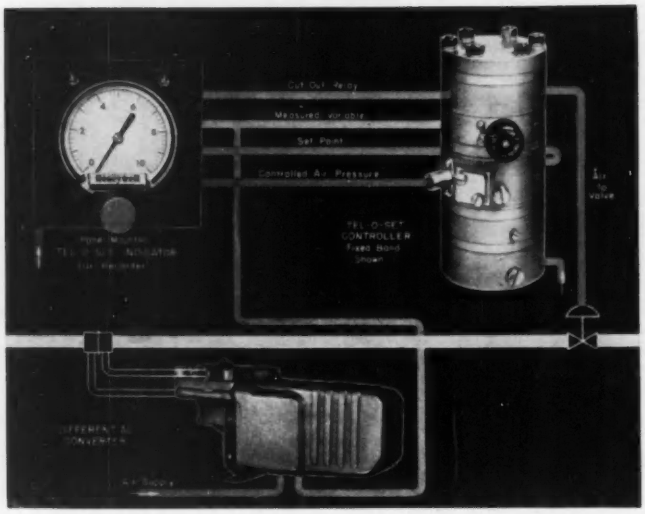
Controller Uses Pneumatic Balance Principle

Components of a new flow control system are the differential converter, the indicator, and a miniature recorder. To this system has been added the Tel-O-Set controller, an easily installed, compact unit, that offers advantages such as: good sensitivity, instant response to process change, and a pneumatic balance principle of operation to eliminate friction and lost motion. These units are also available for control of temperature, pressure, liquid level, and other process variables.

Two types of controllers are available: the fixed proportional band and the adjustable proportional band. These units are constructed of a number of coded, interchangeable sections, separated by diaphragms. Air passages are drilled in the various sections. Except for manual adjustments of reset on the fixed band unit, and reset in the adjustable band unit, the Tel-O-Set controllers operate entirely in response to pneumatic signals.

The controller is a fast-response pneumatic balance unit which responds to difference between the two transmitted air pressures which it receives —one corresponding to the measured variable and the other to the set point—by diaphragm movements which adjust a sensitive flapper-nozzle combination within the controller. Air output from a pilot relay is used to adjust the control valve and to modify the response of the controller itself. The controller continues to readjust the output until the measured variable pressure is equal to the set point pressure.

When using the Fixed Band controller, and the set point has been placed upscale by manual readjustment of a Tel-O-Set indicator, this action increases the transmitted air pressure to the set point chamber and, through the linkage mechanism, the flapper is moved toward the nozzle. This flapper movement increases pressure in the nozzle pressure chamber and to the pilot relay in the pilot section.



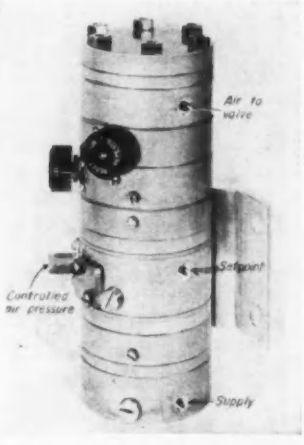
THE FIXED PROPORTIONAL BAND CONTROLLER as connected with the Tel-O-Set Indicator, and the Differential Converter. Like the adjustable controller, it is fixed at 150 percent with reset adjustable from 0.2 to 100 repeats per min.

The increase in pilot relay pressure produces the following effects: (a) It changes the pressure within two diaphragm chambers at opposite ends of the balancing section; instantaneously in the negative balancing chamber; (b) It changes the controller's output to the control valve so that flow is increased, therefore returning the measured flow toward the set point; (c) It changes the pressure (through the reset restriction of the reset section) in the positive balancing chamber.

The fixed band unit is a compact controller equipped with a single reset adjustment dial. It is $6\frac{1}{4}$ in. high and $3\frac{3}{8}$ in. dia; weighs approximately six pounds. Air supply pressure is 20 psi, with output pressure of 3 to 15 psi. Process variable and set point pressures are also 3-15 psi. The proportional band is fixed at 150 percent with reset adjustable from 0.2 to 100 repeats per min. An optional integral by-pass relay provides bumpless transfer from automatic to manual operation. A universal bracket is supplied for control room, valve yoke, or structure mounting. A split manifold permits removal of the controller while on manual by-pass.

The adjustable band Tel-O-Set controller is approximately 9 in. high and $3\frac{3}{8}$ in. in dia and weighs $8\frac{1}{2}$ lb when equipped, with the by-pass relay.

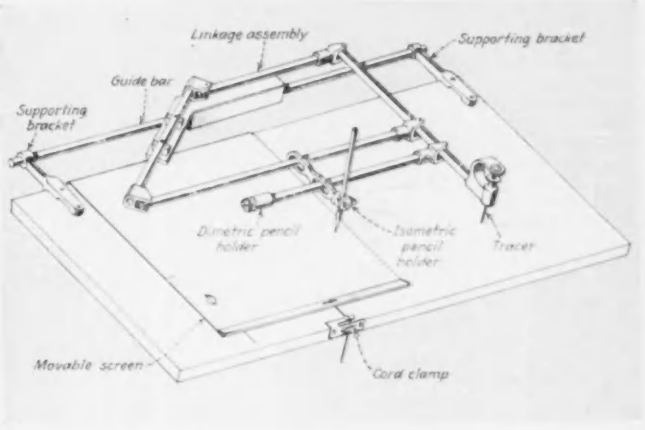
Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Philadelphia 44, Pa.



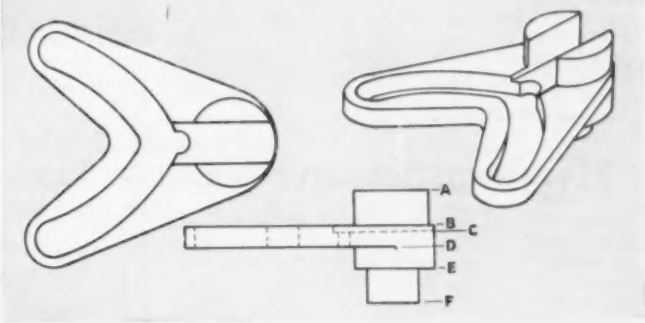
Isometric and Dimetric Drawings Made Simple

Isometric and Dimetric views of detailed engineering drawings have become simplified with the introduction of the Vibax, a drafting machine that will automatically produce isometric or dimetric views by tracing over the lines of a standard orthographic drawing. Ellipses will be exact, and lines will be at the correct angle and to the same scale as the original drawing.

The Vibax may be installed on any drafting board in a few minutes. The guide bar brackets are screwed to the upper face of the board and the mount for the screen and roller to the underface. A half round metal moulding is secured to the rear edge of the board to insure smooth operation of the screen. The cord clip is screwed to the front edge of the board. No accurate measurements or special adjustments are necessary. When not in use it hinges back off the board.



In making an isometric view, the original drawing must be studied to determine at which levels the various sections will appear. As in the illustration, the elevation view is marked A, B, C, D, E, F, to designate the various levels. Then the dimensions, AB, AC, AD AE, and AF are noted. Using these dimensions, a height scale is made on a small piece of paper and taped to the board at the left edge of the moving screen. This acts as a guide for moving the screen to each level when making up the drawing. This height scale is made with a special rule included in the accessories, in which each inch gradation is actually 0.816 in. long. A sheet of paper is taped to the screen, and the original drawing is taped on the board to the right of the screen at an angle of 45 deg. This causes, in the tracing operation, the two visible faces to appear in the same proportion. (For cylindrical sections, no specific angle of the original drawing is required.) A register line on the screen is set to correspond to A in the height scale. After drawing the ellipse and other lines on the A level, the screen is moved to the B line, and so on in subsequent operations.



In drawing the ellipse, a plastic radius arm is used with its center pin pushed in the circle center of the original drawing. The arm has a large number of closely spaced holes. The tracer point is inserted in the hole corresponding to the circumference of the circle, and operated like a compass. The pencil in the holder will draw an ellipse.

For a dimetric view, in which one side appears lengthened by a ratio of 2:1, the pencil is moved to the dimetric pencil holder, and the original drawing taped to the board at an angle of 20.5 deg. The height scale is made with a dimetric scale. Each inch gradation on this rule is actually 0.943 in. Capacity specifications are: isometric and dimetric ellipse major axis have a max of 14 in. and a min of 1/16 in., max horizontal line is 26 in.; for an isometric vertical line, the max tracer point travel is 12⅞ in. while the max pencil travel 7 in.; for a dimetric vertical line the max tracer point travel is 11 in., while the pencil travel is 3⅝ in. Drawings larger than some of the maximum sizes mentioned may be made by taking one section of the drawing at a time.

Indamer Corp., 11 W. 42 St., New York 18, N. Y.

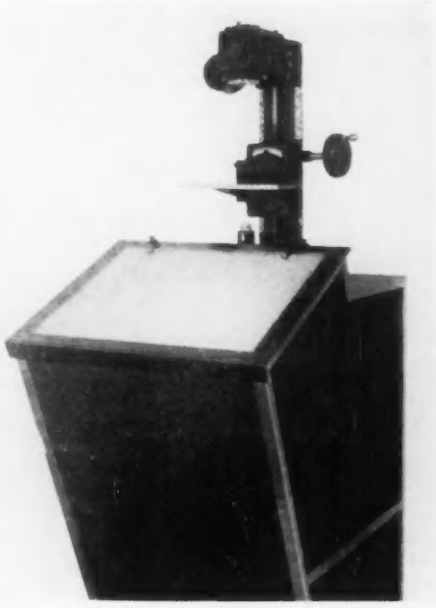
CONTINUED ON PAGE 210

Optical Comparator Lens Give Long Focal Length

The new optical comparator (Model C-100), a new instrument incorporating different mechanical and optical features, has a super-light condenser lens unit which is power cooled and provides good screen definition. When used with color filters, the intensity and shading of light may be varied. This new comparator, called the Century, also offers the advantages of a new stage design. This new staging assembly provides large working space, and includes a so-called swing feature permitting the entire stage and work piece to be moved completely to one side allowing the change over of lens units without disturbing work set-ups. The stage assembly is adjustable by means of built-in controls for helix angle positioning, and the entire stage may be removed, permitting special production type fixtures to be mounted directly to the stage carrier base.

The new Ciptar-Scope optical system has been designed by this company to complement the large mechanical capacity of this new comparator. The special Ciptar lens provide long focal lengths, maximum light, large objective areas and sharp definition. Focal lengths average in excess of three inches. In addition, the screen image is oriented with respect to the position and movement of the projected part. Magnifications of 10X, 20X, 25X, 31½X, 50X, 62½X, and 100X are obtainable as standard equipment with this comparator.

A 16 x 20 in. sight-line screen and frame is provided permitting the use of drafting instruments and vernier protractors for direct tracing and measurement of projected images from a straight edge guide bar. The chassis for the model C-100 comparator is of heavy construction in order to assure permanent alignment of all mechanical and optical components. Overall dimensions are: height 64 in., width 23 in., depth 35 in., weight net 350 pounds.



Pratman Instrument Co., 6 Manhasset Ave., Port Washington, N. Y.

Hydrogen-Sensitive Vacuum Leak Locator

A new portable, high-sensitivity leak locator has been designed as a factory and laboratory device for detecting and locating tiny leaks during the manufacture of electron tubes of all types, vacuum bottles, or any device, large or small, which can be evacuated. Some of its uses are: locating leaks in vacuum stills, vacuum furnaces, mass spectrometers, cyclotrons, experimental vacuum research equipment, vacuum coating equipment, refrigeration equipment, electron microscopes, and infra-red spectrometers.

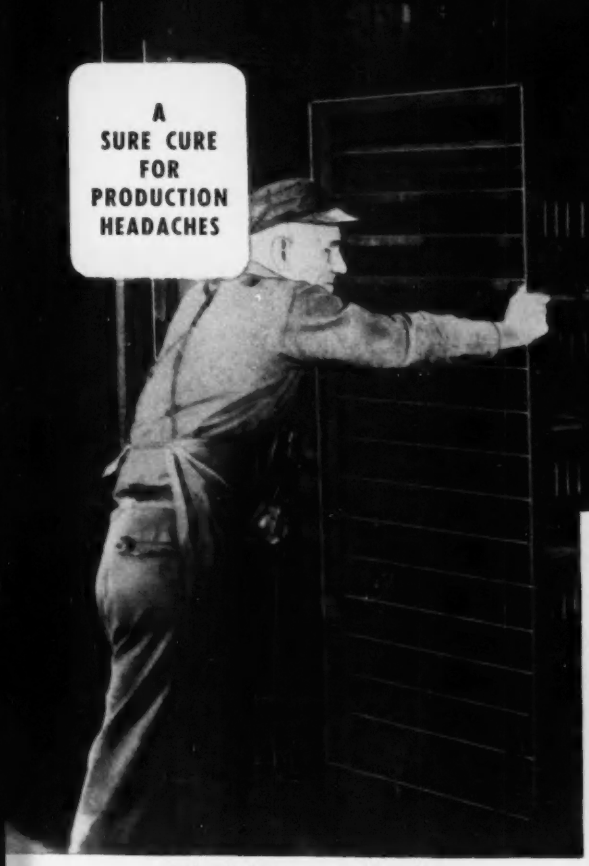
A hydrogen-sensitive, ionization-type instrument, the new Leak Locator, type EMV-7, weighs 31 lb and may be operated by non-technical personnel. It has been designed for fast and more reliable performance and simplicity of operation. Its vacuum system can be pumped down, ready to operate, within two minutes. Rigid construction and improved mechanical design are said to offer good performance. The instrument is capable of detecting leaks as small as 1×10^{-5} liter-microns of hydrogen per second.

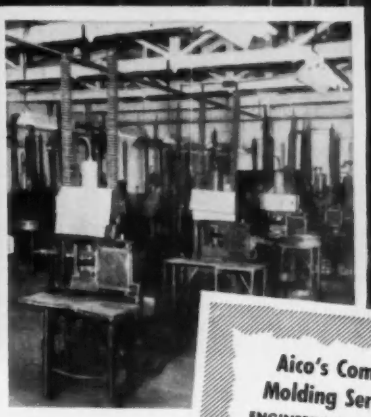
The heart of the leak locator is a sealed-off, high-vacuum-gage tube, RCA type 1945, which responds only to hydrogen. The instrument itself is complete with a high-stability d-c amplifier, microammeter, self-contained power supply, and an all-metal exhaust system and cold trap.

Radio Corp. of America, Camden, N. J.

CONTINUED ON PAGE 212

A
SURE CURE
FOR
PRODUCTION
HEADACHES





Cold molded parts are cured in baking ovens after molding at room temperature.

Aico's Complete Plastic Molding Service Includes:

ENGINEERING COUNSEL on proper molding methods and materials.

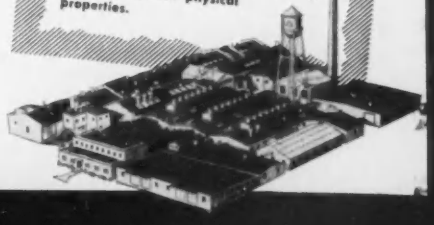
MOLD BUILDING to avoid division of responsibility.

INJECTION MOLDING for high rate of production . . . low unit cost.

COMPRESSION MOLDING of large parts with heavy cross sections.

COLD MOLDING of electrical parts requiring high heat resistance.

REINFORCED PLASTICS . . . a relatively new development in low pressure molding of reinforced resins . . . especially suitable for large moldings requiring special physical properties.



use Aico Cold Molded Plastics

a technique offering a low mold cost, a high rate of production from materials highly heat resistant

Aico Cold Molded Plastics are widely used for electrical parts that must withstand continuous exposure to high temperatures without distortion.

Cold molding was the original method of molding plastics. American Insulator, as a pioneer molder, has long maintained a complete cold molding department, fully equipped for efficient production from the compounding of both organic and inorganic materials to the finished molded product. Presses range from 5 to 200 ton capacities.

Aico's complete plastics molding service . . . all methods of molding with all types of materials . . . offers a sure cure for many of *your* production headaches. Aico is one of the few plastic molders in a position to make an unbiased recommendation on the most economical, suitable method of molding your plastic parts. Drop us a line today.

AMERICAN INSULATOR CORPORATION
NEW FREEDOM, PENNSYLVANIA

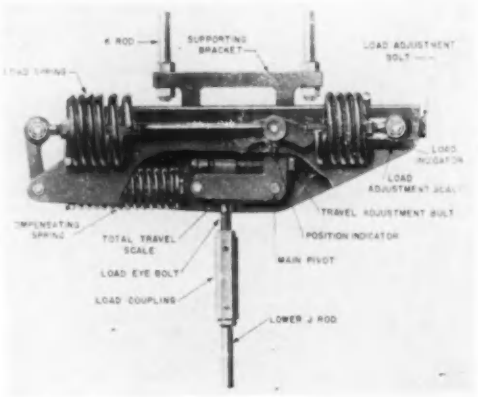
Aico plastics

Hanger Provides Equal Lift in All Positions

The function of the new constant-support hanger, known as model L, is to provide equal lift in all positions of travel of a piping system as it moves from expansion or contraction between its hot and cold positions. Its features are: a center support which places equal dimensions on each side of the center supporting line; non-resonance in spring system; provision to give less horizontal shift of the load line as the load shifts from cold to hot positions. Maximum travel with constant support has been increased to 5 in. in the medium chassis, and from 8 to 10 in. in the large chassis. The load capacity has been increased with fewer springs and chassis sizes.

Discrepancies between calculated hanger loads and actual loads can be corrected in the field at the time of installation by making an adjustment of the position of one nut on the model L hanger where previous models required three separate adjustments. This field adjustment is possible because the compensating spring in the model L requires no adjustment with a change of load setting.

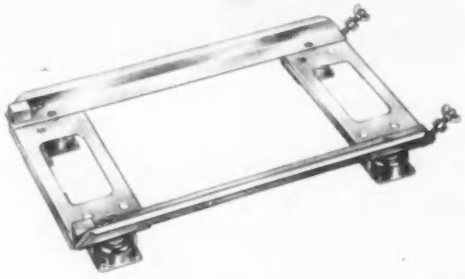
Grinnell Co., Inc., Providence 1, R. I.



Ruggedized Unit Vibration Isolators and Mounting Bases

Vibration isolators and mounting bases are now available in ruggedized construction, to withstand the severe shocks of arrested landings in aircraft carrier service and of crash landings. These units are tested to meet the shock-test requirements of Specification AN-E-19, for the equipment sizes listed in JAN-C-172A.

Ruggedized unit vibration isolators cover load ranges between ¼ lb and 40 lb per unit mount, and are interchangeable with other isolators now in use. They are available both in the air-damped type and in the All-Metl type. Ruggedized mounting bases, equipped with these types, are available in standard JAN sizes (JAN-C-172A) and in special sizes to meet any requirements. Featured is the gain in strength of the base framework itself—beyond JAN requirements—achieved with little increase in weight for loads up to 50 lb. For greater loads and strength, the ruggedized bases are of stainless steel instead of aluminum.



The Barry Corp., 830 Pleasant St., Watertown 72, Mass.

Electroplated Steel Wire With Copper Coating

A new type of electroplated copper-on-steel wire suitable for industrial, electrical, and communications applications, is said to be lighter and stronger than the solid copper wires which require 85 percent more copper. Known as Copperon wire, the electroplating process was invented by the manufacturer. Different from copper plated wire, the manufacturer claims that Copperon cannot be destroyed by changes in temperature, by pounding, or by hot rolling or cold drawing.

Relatively heavy cross-sections of the initial product are cold drawn to require diameters without change in the ratio of copper to steel or impairment of the bond between the two metals. Since the steel core is lighter than copper "Copperon" wires are said to provide about 10 percent more footage per lb than solid copper wires of the same outside diameter. They are available in diameters ranging from ⅜ in. to the finest wire gage sizes.

The heavy electroplated copper coating is permanently bonded to a low, medium or high carbon steel core wire for applications including: plating rack springs; float racks and lift rods for plumbing products, power transmission, telephone and railway signal lines; television antennas and transmission lines; coaxial cables; heavy duty appliance cords; incandescent and fluorescent lamp leads; home appliances; and other industrial applications.

Kenmore Metals Corp., 580 9th St., Jersey City 2, N. J.

CONTINUED ON PAGE 215

CUT COSTS

with the Original Mead

MIDGET AIR CLAMP

(Spring Return Air Cylinder)

In assembly jigs and other multiple applications, this new, low cost pressure unit saves countless man-hours. As a work-ejector in many fixtures, it is unexcelled.

Advantages over mechanical clamps

1 **All Air Clamps** in any set-up can be operated by a single master valve—the "lock-up" and release of assemblies is instantaneous.

2 **May be installed in cramped corners** difficult to reach with bulky mechanical clamps. Mead Midget is the most compact air cylinder, for its power, on the market.

3 **Equal ram pressure at any point** along stroke, making special, delicate adjustments unnecessary.

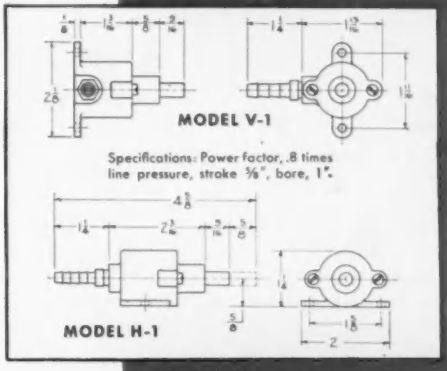
4 **Independent group control.** Any desired group of "Midgets" can be controlled independently of any other group in an assembly—as where primary members of the fixture must be locked up before the secondary members.

5 **Facilitates delicate drill operations.** Air Clamps actuated by foot control valves leave operator's hands free to handle the work pieces.

Send for all the interesting facts on these time-tested, superior Midget Air Clamps.

MEAD SPECIALTIES COMPANY

4114 North Knox Avenue • Dept. PE-111, • Chicago 41, Illinois



IMMEDIATE DELIVERY

Single-acting cylinders delivered from stock; double-acting in a few days.

Tear Out MEMO Coupon Now For

***New* MEAD INDUSTRIAL AIR POWER CATALOG**

Full of suggestions for faster, cheaper production with famous MEAD AIR-POWERED Cylinders, Valves, Presses, Vises, Chucks, Hammers, Dial Fixtures, Work Feeders, semi-automatic combinations, etc. Send today!

Memo Coupon

MEAD SPECIALTIES CO.

4114 N. Knox Ave., DEPT. PE-111, Chicago 41, Illinois

Send free copy of new, colored MEAD INDUSTRIAL AIR POWER CATALOG describing the complete line of famous Mead air-operated devices.

Name_____

Company_____

Address_____

City_____ Zone____ State_____

C/R

PICK FROM THE RECORD

...any measure of superiority ... performance, dependability, engineering, design, availability ... and you'll find C/R "Perfect" Oil Seals the pick of the lot. For better than thirty years, C/R engineers have pioneered to find the perfect answer to oil and grease retention. Today, in addition to many specially designed seals to meet new and different problems, C/R offers you 16 standard types and 1800 sizes.

When you specify C/R Oil Seals you know you are getting the world's finest sealing device.

PROOF? The records show: C/R Oil Seals are standard equipment on more makes of motor vehicles, farm implements, road machinery and industrial machines than any similar device!

Chicago Rawhide engineering service is always available for the solution of your particular sealing problems.

ENGINEERS: We will be pleased to send you engineering data on "Perfect" Oil Seals on receipt of your written request.

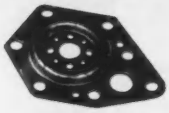
CHICAGO RAWHIDE MANUFACTURING CO.

1299 Elston Avenue **OIL SEAL DIVISION** Chicago 22, Illinois

sirvis

Mechanical Leather Products

Boots, diaphragms, packings and other products give dependable service under difficult operating conditions.



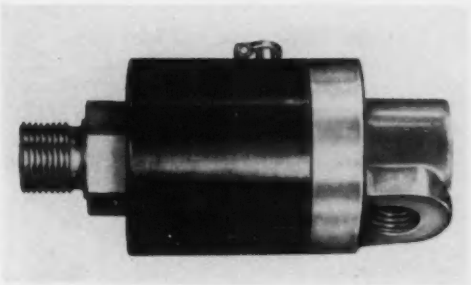
SIRVENE

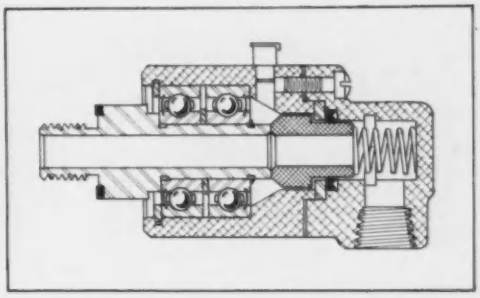
The Scientific Compounded Elastomer

Custom-engineered and custom-built for critical service in aircraft, automotive and other mechanisms.

C/R PERFECT Oil Seals

Air Line Union Used on Rotating Parts





A new rotating air union, model 1105, has been developed for the efficient transmission of air from stationary to rotating machine parts. It has a leakproof feature because of micro-lapped surfaces and a new method of balanced sealing.

It offers a constant minimum starting and running torque because of the method of balancing the air within the unit, and two sealed-for-life ball bearings. Balanced sealing is said to offer longer seal life because the line pressures do not increase load on the seal faces. Two single row matched ball bearings allow a maximum operating speed of 3,500 rpm at a maximum air pressure of 150 pounds.

Because of the assembly, if the sealing faces show signs of wear, they may be replaced without removing the union from the equipment. Only the seal face is expendable, not the whole union.

The model 1105 has lapped surfaces of graph-mo tool steel and carbon to form the leakproof seal. The housing and end bell are of aluminum. It is available in two types, the standard shaft mounting type; and the special in-the-shaft mounting type which reduces overhang. Overall dimensions of each is $4\frac{3}{16}$ in. in length by $1\frac{3}{4}$ in. diameter. The connecting pipe nipples are available.

Deublin Co., 1155 Waukegan Rd., Glenview, Ill.

Miniature Resistors With Values to 12,000 Ohms

Trade named the Dalohm RH-25 resistor, these miniature resistors offer high resistance per watt per cu in., with values from 1 ohm to 12,000 ohms, and tolerances of one and three percent.

The resistance element is wound on a thermal-shock resistant refractory-tube. The resistance wire is spot welded to nickel alloy caps pressed on the refractory. Heavy copper terminals are shaped and silver soldered on nickel alloy caps which give positive low resistance. The entire resistor element is coated with a high thermal conductivity silicone treatment. Over this coating are two servings of glass sleeving. This unit is then impregnated in high dielectric strength and high dielectric constant silicon material. The resistor element completely coated and sealed is housed in a die-cast black anodized radiator finned housing.

The resistor is made in 2, 5, 10, 25, and 50 watt sizes. Tolerances as high as 0.05 percent can be furnished. Resistance shift is less than 0.00002 percent per degree.

Dale Products Inc., Columbus, Nebraska

EC-1139 is a corrosion preventive intended for application on polished metal parts of automobiles such as bumpers, grilles and moldings. Designed to withstand the corrosive action of atmospheric humidity, industrial smog and road salts, it provides a transparent, colorless protective film which barely reduces the luster of most bright metal surfaces. It will not change color after prolonged exposure to sunlight and is resistant to abrasion, shock and general abuse. This coating is not intended for use on copper or its alloys because they discolor easily. Its base is synthetic resin. Xylene can be used as a thinner. This coating is intended for production spray application. A brushable type is also available. Minnesota Mining & Mfg. Co., 411 Piquette Ave., Detroit, Mich.

CONTINUED ON PAGE 216

Testing Desk Measures Magnetization Hysteresis

A new d-c magnetic testing desk has been developed which contains all of the major components and auxiliary equipment necessary for making routine d-c magnetization and hysteresis tests, and simple flux measurements.

The desk, is designed to be used in conjunction with various permeameters and magnetic devices which make possible the testing of nearly all types of magnetic materials. These include soft magnetic sheet, strip materials, and high-coercive-force compositions such as alnico, silmanal an cobalt platinum magnet alloys. The unit is capable of measuring intrinsic saturation induction on various magnetic materials over a range of 200 to 4,000 oersted; permeabilities of 1.005 to 4.0; high field strength up to 15,000 oersted; uncompensated permeameters. It has wide application in the laboratories of manufacturers interested in the magnetic properties of iron and steel.

Complete enclosure of instruments in the light-weight aluminum desk, adds to the safety of the testing device, as well as protecting the equipment from dust and physical abuse. Another feature of the new testing desk is its sloping-desk top which places all controls within easy reach.

It has a base of 5 ft 4 in. by 2 ft 6 in., a height of 4 ft, and weighs 600 lb. Its normal range of current control, depending upon the auxiliary equipment, extends from zero to 40 amp. Accuracy is ± 0.1 percent scale. It operates on moderately steady 125 v d-c supply and 115 v, 60 cyc a-c.

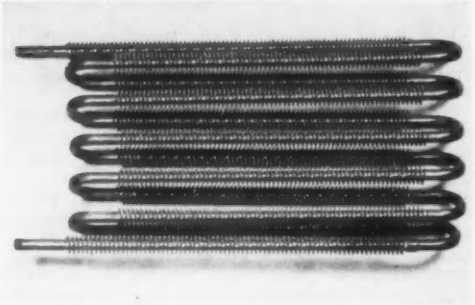
General Electric Co., 1 River Road, Schenectady 5, N. Y.

Surface Design Increases Heat Transfer

A new type surface design has been developed which is said to increase heat transfer from 1½ to 5 times over conventional designs. This process, known as Thermek, mechanically lifts material from the parent metal of the tube, allowing that material, known as spines, to remain attached to the original tube. Sufficient wall thickness is allowed in the original tube to provide for the spined surface and still have a suitable wall thickness.

The Thermek process offers more heat transfer per pound or foot of material; reduced space requirements; greater flexibility of design; turbulent flow in any direction; lower manufacturing costs.

End preparations are available for rolling, welding, or screwed fitting. Sizes are from ⅛ in. to 1½ in., and are manufactured in copper, steel, aluminum, stainless steel, cupro-nickel, admiralty metal, and Inconel. The standard number of spines per turn are 6½, 13, 26, or 52. The nominal longitudinal spacing or pitch of the spines may be varied from ⅛ in. to ½ in. For a standard pipe size copper pipe of ¼ in. the max outside dia over the spines is 1⅜ inch. For a 1¼ in. pipe the outside is 3¼ inches.



Heatron, Inc., P. O. Box 54, York, Pa.

A NEW ELECTRICAL TAPE, made with Koroseal material, claims outstanding features for electrical tapes. Among these features are the following: adhesive is non-transferring, and can be pressed onto a dry surface innumerable times without losing its stickiness; it will not transfer the adhesive from the fate, lose its tackiness, or ability to adhere, and sticks securely to itself and insulation around copper wire; the tape has a dielectric strength of 8,000 v, is waterproof, highly abrasive resistant and flameproof, resistant to acids, oil alkalies and corrosive salts. The tape is extra thin, takes up less room in junction boxes and other tight quarters. The tape is packaged in a roll 60 ft long, is ¾ in. wide, and 0.007 in. thick. B. F. Goodrich Co., Akron, Ohio.

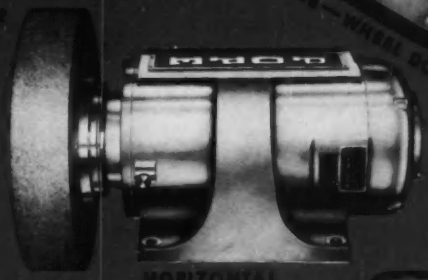
CONTINUED ON PAGE 218

Specify POPE

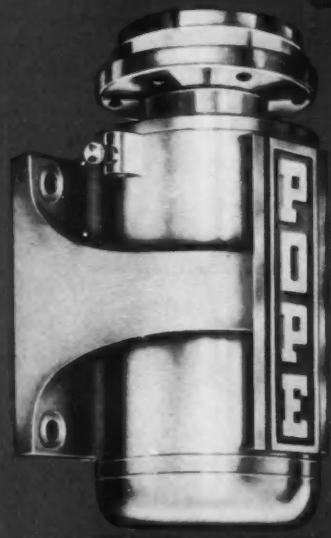
2500 SERIES—HEAVY DUTY MOTORIZED SPINDLES

OBLIQUE—WHEEL UP

OBLIQUE—WHEEL DOWN



HORIZONTAL

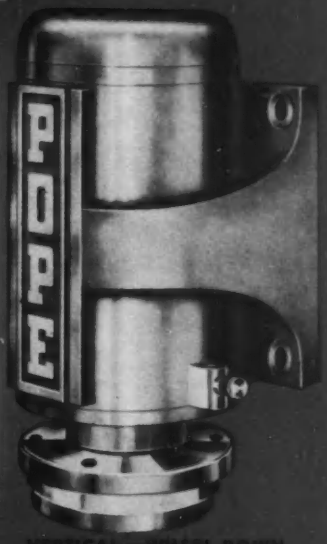


VERTICAL—WHEEL UP

for
BORING MILLS
SURFACE GRINDERS
PLANERS
and other machine tools

These POPE Spindles have the extra power bearing capacity and rigidity to do the work *faster and better*

Write for new Catalog No. 58A



VERTICAL—WHEEL DOWN

POPE

TRADE MARK REG. U.S. PAT. OFF.

POPE MACHINERY CORPORATION

ESTABLISHED 1920

261 RIVER STREET • HAVERHILL, MASSACHUSETTS

BUILDERS OF PRECISION SPINDLES

Four-Way Valve With Two Directional Control

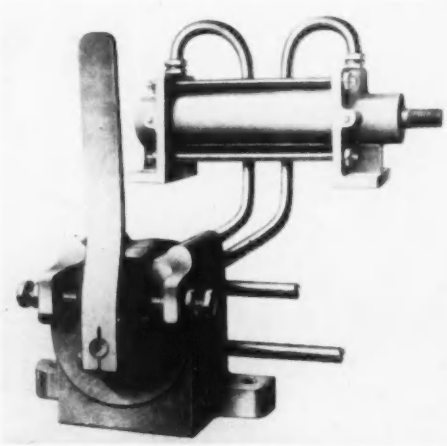
Three and four way valves for air and hydraulic use have been developed that have eliminated the use of two additional speed control valves used on the conventional four way valve. Requiring a maximum of 70 deg of lever movement, all models of the four way valves may be used as three way valves by plugging either of the two cylinder ports.

Called the Sincro Valves, each is designated by the action for which they are used. The S.C. means a built in speed control, and a neutral position. The Q.A. means quick acting with minimum lever movement, but without speed control and neutral position. The O.C. means open center for hydraulic use. Known as the by-pass type, it has no speed control.

The valves are made in three models: hand operated; foot operated with spring return; and foot operated with rocker pedal. All models come in four sizes: $\frac{1}{4}$ in., $\frac{3}{8}$ in., $\frac{1}{2}$ in., and $\frac{3}{4}$ in. I.P.S. All valves are built to operate from 0 to 250 psi.

Independent regulation of stroke speed in each direction allows for choice of cylinder speeds from 0 to full valve capacity on all S.C. models. The direction of the lever indicates the direction of the flow.

The oscillating disk and seat used are said to improve with use. For air and oil, the disk and shaft are brass, while the body and lever are iron. The valve stems are



sealed with airplane type "O" rings, allowing valves to be used for air or hydraulic service.

Wisler Engineering & Machine Co., P. O. Box 204, Sturges, Mich.

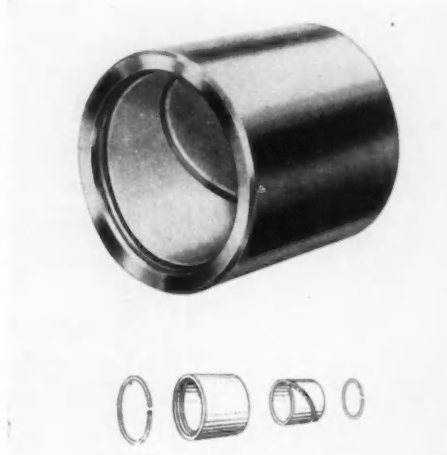
Bearing Liner Adjusts to Dimensional Changes

Being tough, resilient, highly resistant to abrasion, able to stand temperature in excess of 250 F, and unaffected by most ordinary industrial chemicals, are some of the features claimed by the manufacturers of the new Nylined Bearing. It also performs well under adverse lubricating conditions, or with no lubricant at all.

A typical Nylined bearing, as illustrated, consists of an outer sleeve of inexpensive metal and a thin lining of Nylon bearing material. The Nylon liner is retained in the outer sleeve in a manner which will permit it to expand and contract circumferentially around the inner surface of the outer sleeve. The liner is provided with a narrow slot, or compensation gap, cut in the circumference. In applications where lubricants can be used, one or more annular grooves are provided on the inside of the outer sleeve to form storage wells for grease or other lubricants which are evenly distributed through the compensation gap. The tough glazed surface which develops on Nylon results in low friction coefficients with a comparable low rate of wear. It tends to damp mechanical vibration and provides quiet operation.

Dimensional changes in the Nylined liner, caused by thermal expansion and moisture absorption, are taken up by the compensation gap with no appreciable effect on the diameter. Therefore, there is no danger of seizure due to stress deformation.

Nylined bearings can be furnished in the plain sleeve type or the flange type. When substantial thrust loads must be carried in addition to radial loads, the bearing is



usually laid out to provide a separate surface of nylon bearing material to take the thrust. Bearings can be fabricated to special dimensions and furnished on a custom basis designed for each application.

Thomson Industries, Inc. Manhasset, L. I., N. Y.

CONTINUED ON PAGE 220

Can *You* Use the "Utiliscope"?

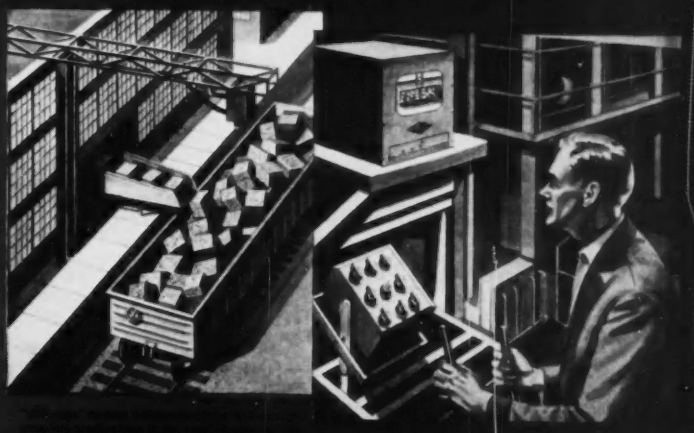
The advertisement at the right appeared in BUSINESS WEEK. It has been suggested that this ad contains considerable food for thought for the readers of PRODUCT ENGINEERING also. The particular application illustrated here may not interest you but it probably will suggest other uses for the "Utiliscope" in your operations.

If you want to look into the possibilities of the "Utiliscope", simply write us for a copy of Bulletin 1025J which explains the equipment and shows various applications. Please address your request to Department "J".

DIAMOND POWER SPECIALTY CORP.
Department "J"
Lancaster, Ohio

NOW You Can *See* Where You Can't *Look*

DIAMOND "UTILISCOPE"



Here is another operation where the Diamond "Utiliscope" (wired television) saves manpower . . . enables one man to do the work formerly done by two.

The "Utiliscope" extends the power of the eye so you can SEE where you can't LOOK. Obstacles that prevent direct observation (such as danger, building members, discomfort, distance, etc.) are easily overcome by the "Utiliscope."

The "Utiliscope" is surprisingly simple and low in cost. No special skill is needed for installation and operation. Stability and reliability are exceptional . . . the "Utiliscope" is readily adaptable to outdoor mounting.

Let us tell you about numerous operations where the "Utiliscope" is preventing accidents, saving labor, improving product quality and increasing production . . . ask for Bulletin 1025.

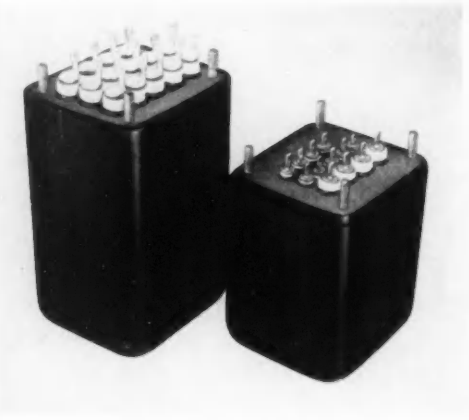
TYPICAL USES—

DIAMOND POWER SPECIALTY CORP.
FIRST IN INDUSTRIAL TELEVISION
LANCASTER, OHIO • *OFFICES IN 39 PRINCIPAL CITIES*
Diamond Specialty Limited — Windsor, Ontario
Since 1903, Diamond has Manufactured Quality Equipment For Industry

WRITE FOR BULLETIN 1025

Electrical Insulation Saves Space and Materials

Quinterra Type 3, an asbestos-base, silicone-treated, high temperature electrical insulation, is a Class H insulation, as defined by AIEE standards, for service at a temperature of 180 C. Silicone-treated, it is used for both inter-layer and wire wrapping insulation. It is adaptable to a wide range of electrical devices including air cooled, inert gas, and silicone filled transformers. Some of the advantages it offers are savings on materials, a greater factor of safety and the opportunity for more compact design. In the illustration, the transformer at left contains conventional insulation. The transformer at right has Quinterra 3.



Quinterra Type 3 maintains a dielectric strength of at least 350 vpm under continuous exposure to Class H maximum temperature of 180 C. This dielectric strength remains practically constant even under continuously high humidity, since it has high moisture resistance.

Quinterra Type 3 has good mechanical strength and physical properties. The base sheet of purified asbestos is completely inorganic, and of closed structure with no holes. When silicone-treated, it is uniform in both texture and thickness. Thus winding dimensions can be predicted accurately. It is flexible for easy handling during application and resistant to cracking or crazing.

It is supplied in the form of sheets, rolls and tapes. Widths can vary from $\frac{1}{4}$ in. to 36 in. and will be factory cut to specification. Available thicknesses are from 3 to 9 mils. Insulations can be used alone or it can be combined with other dielectric materials such as mica or glass cloth.

Johns-Manville, 22 E. 40 St., New York 16, N. Y.

Dial Thermometer Used With Molten Metals

A special type of dial thermometer called the Temperometer has been developed that because of its construction is particularly adaptable for temperature readings of molten babbitt metal, solder, lead, hot oils, waxes, and other hot liquids.

The actuating element of this instrument is a bi-metallic coil. This is enclosed in a tube. When the tube is placed directly into molten material, heat is transmitted to the sensitive coil. This causes the coil to revolve in proportion to the degree of heat transmitted. A pointer attached to to the end of the pointer shaft indicates the temperature on a calibrated dial.

Formerly, this instrument was made of ordinary steel tubing with a die cast head. The diameter of the tube was $\frac{3}{4}$ in. Fabricating this unit now entirely of stainless steel helps prevent corrosion. Stem diameter is now only $\frac{9}{32}$ in., permitting use of a more scientifically designed bi-metallic coil. The end of the tube has been closed so that solutions cannot enter and foul the coil. Dial layout has been altered for easier reading, and all figures are anodized to prevent fading or discoloration.

The Temperometer is supplied with a handle so that it can be suspended over the lip of a kettle or ladle. It can also be fabricated with a $\frac{1}{4}$ in. NPT mounting nut if desired.

Further information on this and other instruments can be obtained from the manufacturer upon written request.

W. C. Dillon & Co., Inc., 1421 S. Circle Ave., Forest Park, Ill.

CONTINUED ON PAGE 222

5 o'clock Stampede

It's a commonplace scene, that mad rush of traffic. And it illustrates the automotive industry's need for dependable brake linings, clutch facings, and engineered automatic transmission parts . . . the STOP-AND-GO products made by RAYBESTOS-MANHATTAN for so many American manufacturers.

In many other industries, too, R/M friction materials serve with equal distinction. Applications vary from brake blocks for mine hoists to tiny parts for phonograph turntables.

This wide range of service provides a breadth of experience that can be most helpful to you, no matter what your requirements in friction materials. Your R/M representative can work from samples, from designs on paper, or from figures on horsepower development combined with desired performance characteristics. When you call him in, you call on the world's largest supplier of friction materials, with four plants, four research departments, and four testing laboratories.

RM
FIRST IN FRICTION

RAYBESTOS-MANHATTAN, INC.

EQUIPMENT SALES DIVISION • 620 Fisher Bldg., Detroit 2, Mich.

Chicago 11, Ill. Los Angeles 11, Calif. Cleveland 14, Ohio

Factories:
BRIDGEPORT, CONN., MANHEIM, PA., PASSAIC, N.J., NO. CHARLESTON, S.C.
CANADIAN RAYBESTOS CO. LTD., PETERBORO, ONT.

RM

RAYBESTOS-MANHATTAN, INC., Manufacturers of Brake Linings • Brake Blocks • Clutch Facings • Fan Belts • Radiator Hose • Mechanical Rubber Products • Rubber Covered Equipment • Packings • Asbestos Textiles Powdered Metal Products • Abrasive and Diamond Wheels • Bowling Balls

Device Shows All Angles on Photographs

The Photoangulator, a device that shows all the angles on photographs, accurately gives true horizontal directions from oblique aerial photographs.

Military aerial photographs used in the production of most aeronautical charts and small scale mapping, are made with three cameras that simultaneously shoot one vertical and two oblique photographs thus covering a wide area. With the aid of the photoangular, a network of intermediate horizontal control is established from the oblique photographs to which the map is compiled.

There are three principal parts to the photoangulator: a depression angle assembly for adjustment to the depression angle of the aerial camera at the instant of exposure; a transparent photo arm under which intermediate control points are intersected on the photo; a templet arm that juts over the map manuscript gives the true horizontal directions.

Horizontal directions may be produced from 6 in. focal length photography with camera tilts ranging from 40 to 72 deg. A specially designed plastic slide rule calculator enables the operator to obtain quickly the correct photo arm setting. Dimensions are 25½ by 8½ by 3¾ inches.

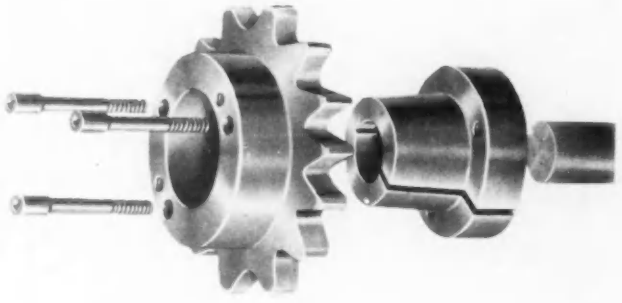
Engineer Research & Development Lab., Fort Belvoir, Va.

Interchangeable Hub Sprocket for V-Belt Sheave

A V-belt sheave, and roller chain sprocket distributor has developed an interchangeable hub sprocket for their QD V-belt sheave hub to eliminate reboring of sprockets and V-sheaves.

The QD sprocket is taper-bored to receive the tapered hub. Bolts are provided to pull the sprocket into the tapered split hub for a tapered drive assembly and a positive press fit on the shaft. Tapped holes in the sprocket permit the use of pull-up bolts as jack screws to break the tapered fit when dismounting the sprocket. Set screw over the keyway holds key in position.

The manufacturer claims that speed changes are greatly simplified at a saving in price, and maintenance and break down time is reduced as QD sprockets can be installed or removed quicker than conventional type. These interchangeable sprockets are available in ½ in. pitch through 1¾ in. pitch.



Fort Worth Steel & Machinery Co., Fort Worth, Texas

A NEW SOLVENT, used mainly for cleaning carburetors, fuel pumps, diesel injectors, pistons, oil strainers, and other metal parts, has good grease cleaning and carbon removing properties. It is a di-phase solvent, comprising a water emulsion floating top layer sealing a volatile chlor-aromatic solvent lower layer. Using the cold immersion method, no heat is necessary. Curren Ordnance Chemical Lab., Lawrence, Mass.

CONTINUED ON PAGE 224

Customer Reports:

NO REJECTS IN 30,000 BUSHINGS MADE OF CONTINUOUS CAST BRONZE!

An aircraft engine manufacturer states that the first 30,000 bushings made of Asarco Continuous Cast Bronze (75% Cu, 5% Sn, 20% Pb) were tested with black light. There were NO REJECTS! Inspection by this means was discontinued as no longer necessary.

Asarco Continuous Cast rods, tubes and shapes offer production economies which are unique. Porosity is virtually non-existent. No sand, dirt or other foreign matter is used in the casting process, so that there are no inclusions to harm tools. Cutting speeds can be high, too. All stock for machining is held to close tolerances and is Medart straightened. Tube concentricities are within 1.5% of wall thickness. Continuous Cast Bronzes are ideal for use on automatic screw machines.

You can get Continuous Cast Bronzes made to order in a wide variety of alloys . . . in standard lengths of 12′ . . . lengths 5′ to 12′ on request . . . lengths 12′ to 20′ on special arrangement.

216 sizes of the standard Asarcon 773 bronze (SAE 660) are stocked in 105″ lengths for convenience at warehouses in principal cities across the country. Distributors will cut the warehouse stock *long or short* to suit your specific requirements.

Send for a free catalog on Asarco Continuous Cast Bronzes. It contains physical properties, photomicrographs, table of stock shapes and sizes, weights and other valuable information.

75% Cu
5% Sn
20% Pb

POROSITY VIRTUALLY ELIMINATED WITH CONTINUOUS CAST BRONZES

Note in these photomicrographs the superior dispersion of constituents in the continuous cast alloy . . . also its outstanding freedom from metal faults.

COMPARISON OF TYPICAL TENSILE STRENGTHS

85-5-5-5 ALLOY

Sand Cast	36,400 psi
Permanent Mold	41,200 psi
CONTINUOUS CAST	45,000 psi

83-7-7-3 ALLOY

Sand Cast	40,400 psi
Permanent Mold	41,600 psi
CONTINUOUS CAST	44,000 psi

In addition to the tensile strength superiority shown above, Asarco Continuous Cast Bronzes have up to 100% higher fatigue characteristics . . . impact strengths increased from 15% to double those of the same alloys cast by other means . . . substantially improved yield strengths, elongation values and hardnesses.

ASARCO CONTINUOUS-CAST RODS · TUBES · SHAPES ®

West Coast Sales Agent:
KINGWELL BROS. LTD., 444 Natoma Street, San Francisco, Calif.

American Smelting and Refining Company

OFFICES: Perth Amboy Plant, Barber, New Jersey
Whiting, Indiana

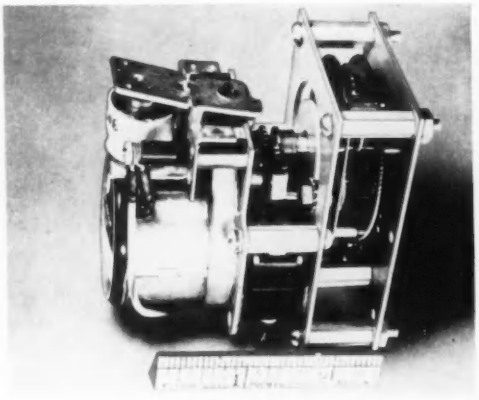
Delayed Reset Time Delay Relay

A new product known as the delayed reset time delay relay makes possible a delayed reset proportional to the time delay and a circuit reclosure time proportional to the length of current interruption. Reset is accurately controlled by an escapement mechanism which adds approximately ¾ in. to the length of the time delay relay.

The delayed reset time delay relay may be used for application as a vacuum tube protective system. It assures the desired delay in feeding high voltage to the plate circuit, holding back the load until the cathodes have reached proper temperature. To provide safety in the event of a power interruption, it opens the circuit.

A typical application is a radar installation in which a 15 min delay is provided prior to closure of the load circuit. The time required for the unit to reset is 7 min. When a current interruption less than 7 min duration occurs, the time delay before reclosure is proportional to the length of current interruption. Thus a 5 min interruption would require only 5 min before circuit reclosure.

The relay was designed to operate under all possible conditions and units are available housed in a standard dust cover or in a hermetically sealed enclosure.



A. W. Haydon Co., 232 N. Elm St., Waterbury, Conn.

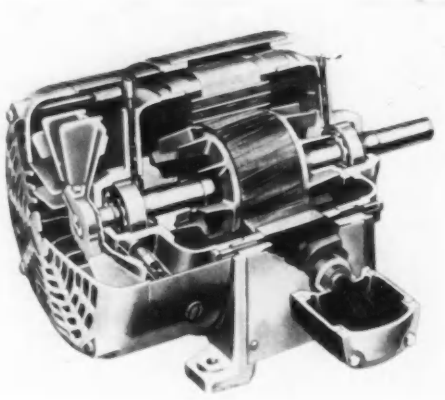
Capacities To 75 Hp In Explosion Proof Motors

A totally enclosed motor, made in capacities from 3 to 75 hp, has been developed to meet explosion proof requirements. This new motor, Types SE and SES, carries the Underwriters' label in Class I, Group D, for highly inflammable gases and volatile liquids, and in Class II, Groups F and G, for combustible dusts. Other types SD and SS without label, for non-explosion-proof services, are also available.

Features incorporated include: sealed terminal, elongated spark-arresting bearing sleeves, streamlined housing, hi-draft ventilation, removable cover, split hub fan, normalized castings, lubri-flush bearings, asbestos-protected windings, and solid, centricast rotor. Being completely sealed, this motor gives protection against external hazards, preventing intrusion of abrasives, acids, moisture and other destructive substances.

Further information on this and other motors may be obtained from the manufacturer.

U. S. Electrical Motors, Inc., 200 E. Slauson Ave., Los Angeles 54, Calif.



A CHEMICAL, having a sharp melting action at predetermined temperatures is now available in crayon, pellet, or liquid form. When working with the crayon, a chalky mark is made. When the stated temperature is reached, the mark will become a liquid smear. This method can be used for all temperatures. Its uses are in welding, forging, heat treating, fabrication of metals, and molding of glass, rubber, and plastics. Pellets are available for temperatures up to 2,500 F. Crayon and liquid form for temperatures to 2,000 F. Southern Oxygen Co., Inc., P. O. Box 5087, Washington 19, D. C.

A NEW GASOLINE FILTER, called the Rayclean model MB has a cast aluminum top and aluminum alloy bowl. When completely assembled it weighs 3¼ oz, including the filtering element. A special non-woven rayon cloth covering each filter disk is said to pick up microscopic dirt particles. Fibers of the cloth cannot come loose. Of light weight and measuring 2¼ in. in height and 2 in. in dia, it can be installed in all types of gasoline engines. Sparkler Mfg. Co., Mundelein, Ill.

—CONTINUED ON PAGE 226

ELECTRUNITE TUBING *Eases Life-*

FOR THE MANUFACTURER...

FOR THE PATIENT...

HOSPITAL PATIENTS can relax in every position, from full-reclining to upright, in this sturdy rejuvenating chair made by Barcalo Manufacturing Company. Steel tubing provides the stiffness and rigidity to make the chair steady and reassuring to the patient, yet light to move.

The manufacturer likes the way ELECTRUNITE Steel Tubing works on this application. Uniform ductility and wall thickness assure rapid, predictable forming and bending of the tubes to shape. Where tube ends must be fully flattened at joints, there's no trouble with cracks and fractures. The excellent surface of this ELECTRUNITE Tubing requires no special handling or trick treatments to hold long-lasting finishes under severe service.

Have you considered using ELECTRUNITE Steel Tubing in your essential products, such as these invalid chairs? We'll be glad to discuss your problems . . . and offer you the benefits of Republic's 3-Dimension Metallurgical Service. It's the helpful service that focuses the knowledge and experience of field, mill, and laboratory metallurgists on your fabrication problems.

REPUBLIC STEEL CORPORATION
STEEL & TUBES DIVISION
224 EAST 131st STREET
CLEVELAND 8, OHIO

Republic REPUBLIC STEEL
ELECTRUNITE TUBING

Portable Engine Analyzer Adjusts Timing

This new portable engine analyzer electronically detects, locates, and identifies detailed ignition and mechanical troubles in power plants containing any number of cylinders.

A cathode-ray tube screen on the analyzer shows the flight engineer or engine mechanic the internal operating condition of the engine while it is running. It warns of cylinder and accessory failures such as bad spark plugs, sticking or damaged valves, and pre-ignition before they can become serious. The analyzer is designed for high altitude airborne use as well as for ground use. It is also applicable to monitoring troubles in aircraft accessories and in any spark-ignition type engine.

Principal feature of the new analyzer is a new timing adjustment which makes setting of the timing generator on the engine unnecessary. By turning a knob shaft on the panel of the instrument, the operator can synchronize the analyzer accurately to any angle of the engine's rotating crankshaft.

Other features are the cathode-ray pattern as calibrated in degrees of engine crank angle. Calibrations are read on a continuous dial of the "cycle selector" control which moves the cylinder events across the screen. This calibration tells the operator exactly when a particular event is occurring in terms of engine cycle time. A new electronic sweep length control keeps the calibration of the cathode-ray pattern constant regardless of the engine's speed. A new switch is provided on the instrument for making the screen show one or more reference markers which are timed to a fraction of a degree to any particular position of the engine crankshaft. The new analyzer can operate on any power line frequency from 50 to 500 cycles.

In the illustration can be seen the cathode-ray scope screen in the upper right hand corner. The cycle control in the left hand corner has calibrated dials which show cylinder numbers and degrees of crankshaft rotation.

The Sperry Gyroscope Co., Great Neck, N. Y.

Oscillator Has Sine and Square Waves Simultaneously

The Model 420-A is designed for applications requiring a source of sine wave and square wave voltages in the frequency range from 0.35 to 52,000 cycles per second. Special circuits have been installed to eliminate transients after tuning or band-switching.

Features are low distortion and good amplitude constancy, with the hum and distortion being reduced when the setting of the output level control is reduced, and maintained at a constant low percentage of the output signal.

The wide frequency range, extending from sub-audio to above the audio range, makes the 420-A useful for servomechanism, geophysical and seismological work, for vibration checks and medical research, and for work with audio frequency circuits.

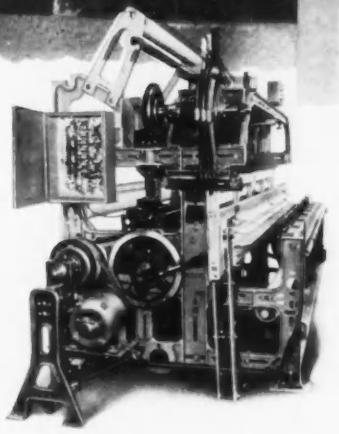
Specifications are: Frequency Range, 0.35 to 52,000 cps, continuously variable in five decade bands. Frequency Dial: single scale, illuminated, direct reading, calibrated logarithmically from 3.5 to 52 on an 8 in. scale, controlled by a 5 to 1 vernier. Sine Wave Output: voltage, 30 v peak to peak maximum, adjustable continuously by a logarithmic output level control with a scale calibrated in rms volts from 0.01 to 10; load, minimum, 1,000 ohms; Square Wave Output: voltage, 10 v peak to peak; load, minimum, 10,000 ohms. Input Power: 105-125 v, 50-60 cps, 45 watts. Tube Complement: furnished with instrument: 4-6SL7-GT, 3-6SN7- GTA, 1-6 SR7, 1-6AX5-GT. Form: aluminum cabinet, overall dimensions 12 in. wide, 7 in. high, 8 in. deep. Weight of complete unit is 17 pounds.

Krohn-Hite Instrument Co., 580 Massachusetts Ave., Cambridge 39, Mass.

CONTINUED ON PAGE 228

FOR VIBRATION INSURANCE

ON *Fletcher* LOOMS



The adjustable throw cranks of the Fletcher High Speed Ribbon Loom are accurately and securely held in position by FLEXLOC Nuts. These cranks are subject to heavy loads at speeds of 200 to 225 RPM. In this difficult application FLEXLOCs have been successfully used since 1946.

The crankshafts on Fletcher High Speed Narrow Fabric Looms *must stay tight*—that's why FLEXLOCs are used to fasten them. FLEXLOCs not only provide *vibration insurance*, but they *promote uninterrupted production* and *cut maintenance costs*.

FLEXLOC also feature: *one-piece, all-metal construction*—nothing to work loose or forget and no serious temperature problem; and *resilient, automatic locking sections* — processed by our patented method to provide closely controlled torques.

Convince yourself of the VIBRATION INSURANCE provided by FLEXLOC! Test-run them on your own product, let us know what size you need and *we'll send samples* with our latest literature promptly.

SPS

STANDARD PRESSED STEEL CO.
JENKINTOWN 28, PENNSYLVANIA

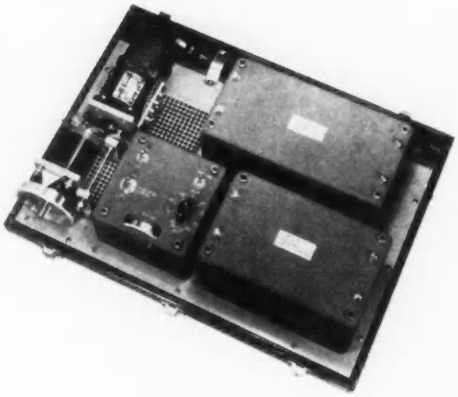
Portable Servo System Used for Demonstrations

Because of the increasing uses in the processing of materials, a portable demonstration servo control system has been developed for office demonstration or for lectures to show what a typical servo mechanism is and does. The demonstrator consists of only five components attached to a mounting board. These are: 1) the station to be controlled; 2) an adapter, which contains the controlling station as well as the many unrelated elements of the system, such as pilot lights and switches; 3) a standard SA-203 servo amplifier; 4) a PS-203 power supply; and 5) a 1/150 hp Diehl motor with tachometer. With five such basic components, selected according to performance requirements, it is possible to solve an almost infinite number of complex electronic and electro-mechanical problems.

To illustrate how a servo system can be applied in problems requiring prompt, accurate remote control of position, the controlled station (on the left in the illustration) and the controlling station (on the adapter-front center) are each equipped with a dial, one the so-called slave dial and the other the master dial. A flick of a switch on the adapter will set the position servo in operation, and the slave dial will assume the same position as the master dial.

It is then possible for anyone to test the performance of the system at first hand. By turning the master dial in any direction it can be determined how quickly the controlled or slave dial follows it, how accurate the response is, and how good the damping is, as shown by the amount of overshoot. A switch controlling the tachometer provides additional damping in order to observe gear-train oscillation which may occur due to backlash. The control of the velocity allows a change of speed for a check on how quickly the system responds to changes of speed and direction.

Servo systems of similar performance characteristics can



be designed to solve problems requiring continuously accurate control of position or speed. For analogue-computing problems, high-performance systems are available which range in mechanical output from fractions of one watt to 5 watts and in size from a few score cubic inches to that of the demonstrator. For industrial problems which require the performance of work, larger systems can be developed. The 5 w unit is often sufficient to operate valves, but larger units are usually required to move physical bodies. Electronic and hydraulic solutions can be offered.

Servomechanisms, Inc., Westbury, N. Y.

Variable D-c 0 to 28 volts Power Supply Unit

The new model N d-c power supply provides a continuously variable source of filtered d-c power (0-28 v) for operating d-c equipment from a-c lines. It may be used in industry, research and the defense program for testing and servicing electronic equipment in tank, air and marine craft; relays and solenoids; telephone circuits; laboratory instruments; research; for plating operations; for university laboratory work and for any low voltage devices.

A feature is the application of selenium rectifiers which increases the rectifier power rating and permits lower cost per amp output. A single control furnishes continuous voltage adjustments for different load conditions over the specified range.

It supplies up to 36 v at 6 amp. The a-c power is approximately 730 w with a 15 amp 28 d-c v load. A-c hum or ripple at 15 amps is 8 percent, at 10 amp 5 percent. Facilities for additional filtering are provided for special requirements. D'Arsenval-type voltmeter and ammeter are accurate to 2 percent. Powerstat provides incremental voltage adjustments. Bridge-type heavy duty selenium rectifiers permit continuous duty at 15 amp. The supply unit operates from a 110-120 v, 50/660 cycle a-c source.

The Model N comes in steel cabinet which measures 14¼ by 14¼ by 9¾ in., and is finished in blue hammerloid.

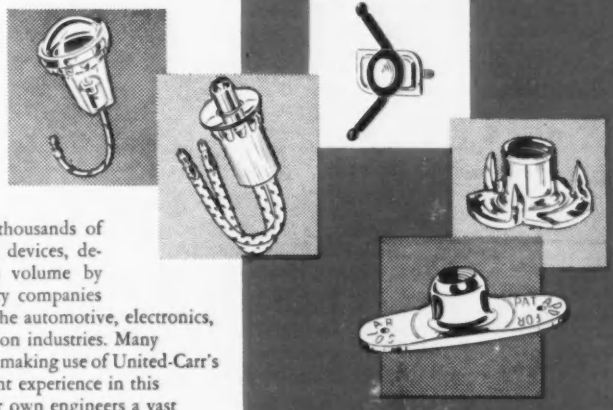
4501 N. Ravenswood Ave., Chicago 40, Ill.
Electro Products Labs, Inc.,

CONTINUED ON PAGE 230

This is a Bug Killer?

You bet it is . . . and more than that it's one of a large and growing family of bug killers. This particular tubing and wiring fastener helps take the bugs out of automotive electrical systems. It holds wires and tubing firmly, without chafing, in the face of extreme vibration. A quick turn and—*snap*—costly machined parts are eliminated.

Working in close cooperation with manufacturers, our engineers have developed thousands of such tailor-made fasteners. Designed to give trouble-free performance in use, these fasteners speed production and cut labor costs as well.



Illustrated are a few of the thousands of different fasteners and allied devices, designed and manufactured in volume by United-Carr and its subsidiary companies to meet the special needs of the automotive, electronics, appliance, furniture and aviation industries. Many manufacturers have found that making use of United-Carr's varied design and development experience in this specialized field can save their own engineers a vast amount of time and trial-and-error experimentation. That's why so many leaders in industry make it a practice to turn first to United-Carr—FIRST IN FASTENERS.

* *Before bidding on government contracts requiring special fastening devices or snap fasteners, consult your nearest United-Carr field engineer.*

UNITED-CARR

UNITED-CARR FASTENER CORP., Cambridge 42, Mass.

MAKERS OF DOT FASTENERS

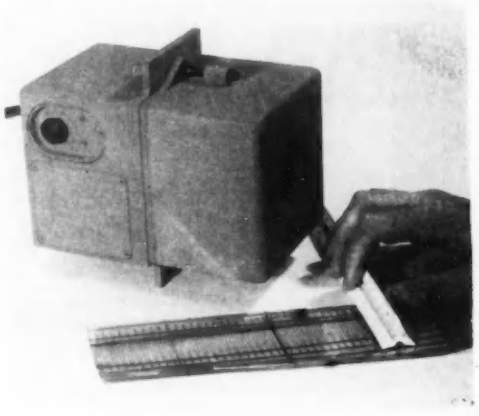
Small Size 9—Channel Oscillograph Records Data

Up to nine sources of data representing vibration, pressure, velocity, strain, or other phenomena, either static or dynamic, can record simultaneously on the new 5x5x8-in. Recording Oscillograph, Type 5-118.

Developed originally for a missile-testing program, this new midget oscillograph produces dynamic test records $3\frac{1}{2}$ in. wide, (see illustration) and up to 40 ft. long on which the nine separate phenomena can be measured with respect to both time and one another.

The type 5-118 recording oscillograph employs the same standard type 7-200 galvanometers as used in the larger oscillographs (Types 5-114 and 5-116 made by this company. The galvanometers are mounted in a stable, cast magnet block to insure uniform, results, and are easily reached for adjustment or replacement when the film magazine is removed. A translucent cover on the galvanometer opening swings back to become a graduated screen for vertical and horizontal adjustment of light spots. Tools for adjustment are stored in the magazine.

Completely light-tight, the magazine separates from the oscillograph and can be handled freely without danger of film fogging. It contains the entire record transport system, which drives the film past the optical system at precisely measured rates. Power connection for the drive motor is made automatically by a built-in connector when the magazine is attached. Design is such that improper attachment is impossible. Operating from a 28-v d-c power source,



this compact test instrument is suited to mobile testing programs, where space, weight saving, and accuracy are of importance, and a variety of testing programs possible.

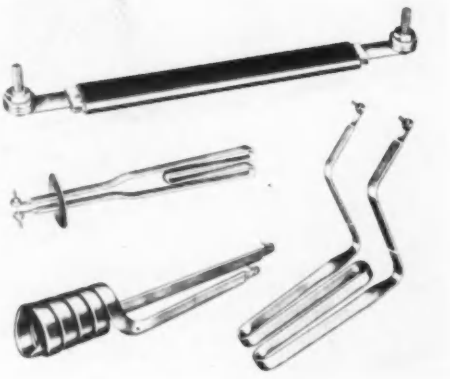
Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif.

Electric Heating Unit Offers Many Shapes

A new, flat, sheathed electric heating element has been developed for industrial heating such as kettles, tanks, ovens, dies, driers, and for immersion in liquids. This unit provides flat surfaces for contact heating, and a thin section, for convection and air flow. Of strong material, it is easily bent and formed, and is resistant to moisture and vibration.

Available in two widths, $\frac{1}{2}$ in. and $\frac{3}{4}$ in., both $\frac{5}{32}$ in. thick and in lengths from 9 to 124 in., the flat surface design offers fast and uniform heat distribution. It also allows forming in various shapes, requiring a minimum of space. The elements are also available in various sheath materials (steel or copper are standard), depending upon the application. Protection from injurious vapors or liquid seepage is provided by special fittings brazed to the sheath. They are protected against arcing to ground and will not fire through the sheath in case the resistor fails or the insulation is punctured from high voltage.

Syntron Co., 240 Lexington Ave., Homer City, Pa.



A NEW PRECISION SNAP ACTION SWITCH especially suited for use in controlling d-c has been introduced. The switch, known as the model TB-5000 is designed for single pole double throw circuits and is rated at 10 amp, 125 v d-c, and at 5 amp, 230 v d-c. The design of this switch incorporates an Alnico magnet which blows out the arc as soon as contacts open or close to prevent burning. The switch base and cover are molded of arc-resistant melamine. Items such as metal enclosures, pin, leaf, or plunger actuators are available. Dimensions of this miniature sized switch are $1\frac{5}{8}$ in. long by $\frac{3}{4}\frac{1}{8}$ in. high by $\frac{1}{1}\frac{3}{6}$ in. deep. Acro Mfg. Co., Canton, Mass.

CONTINUED ON PAGE 232

Will Defense Production Be Caught in the Squeeze?

When Congress revised and extended the Defense Production Act, it relaxed a squeeze on business profits.

President Truman asserted that this action by Congress cripples the government in its effort to prevent inflation which, as he puts it, could lead to "enrichment and profiteering for the few, economic hardship and misery for the many."

He asked Congress to rescind its action.

This editorial—the second on problems presented by "escalator"clauses—aims to throw some light on this conflict of opinion.

The Squeeze

The squeeze on profits was imposed in the name of price stabilization. The idea behind it was simple. The *selling prices* of industrial products were to be held under a tight lid. But many industrial costs are affected by "escalator" clauses of one kind or another which tend to boost production *costs*. Thus, with rising costs and fixed prices, profits would be squeezed and much of the cost of defense would thereby be shifted from those favored by escalator clauses to business concerns.

The mechanics of this squeeze on profits were complicated. But here, in brief, is how it was to work. The first step was to require manufacturers to set ceiling prices, effective May 28, for their products.

These ceiling or maximum prices were to allow for increases in manufacturers' costs that had occurred since Korea. *But they did not allow for all increases.* Manufacturers, for example, could not include increases in indirect costs—office or selling costs. Neither could they, in calculating their new prices, include increases in the costs of materials or direct labor that had come after March 15. This was the first phase of the squeeze on profits.

The second phase was prepared by **not** putting a ceiling on costs. The Wage Stabilization Board said it could not disturb the operation of "escalator" clauses by which wage rates are geared to the cost of living. Moreover, nothing could be done to curb the operation of the farmers' "escalator" clause, the farm parity arrangement. Under it, the federal government underwrites higher prices for farm products to match increases in the cost of things farmers buy. So this left wages and many materials costs free to rise against a ceiling imposed on the prices of what industry has to sell.

Relief—at a Loss

On two conditions only would the Office of Price Stabilization permit a company to raise its prices and escape this squeeze. One of these was that increased costs had more than wiped out its profits; in other words, that it was operating at a loss. The other condition was

that the industry of which the company is a part was not, as a whole, making "excess profits." That is, the industry, as a whole, could not get price relief if its overall profits before taxes were greater than 85 percent of its average profits during the best three of the four years from 1946 through 1949. Many companies expected that their profits would be cut drastically before they could get through this narrow escape hatch.

When this squeeze on profits was set up, we were told that industry as a whole was reporting record profits. But, it was equally true that wage rates and farm prices also were at record high levels. And it was also true that, under the impact of rising taxes and the dislocations caused by the defense mobilization program, profits actually were on the way down.

Profits—Going Down

By the time Congress acted to relax the squeeze, corporate profits, after taxes, were running at a rate 20 percent lower than they had been six months before. And the clear prospect was that they would continue to decline.

So the issue put up to Congress was simply this. Should business firms stand so much of the brunt of the defense costs while "escalator" clauses continued to exempt organized workers and farmers from paying their share of those costs?

But this question actually is much broader than one of fairness or unfairness alone. One certain effect of such a squeeze on profits would be to undercut the capacity of private industry to install the new plants and equipment needed for our mobilization effort. Today—unlike World War II—private industry is financing almost all of our huge program to expand production. And about two-thirds of the money that has been plowed into the expansion and improvement of our industrial machine since World War II has come out of profits.

In view of all this, Congress decided last summer to relax the pressure on profits. This was done by the controversial Capehart Amendment to the Defense Production Act. This amendment has serious administrative weaknesses. But some measure with the same purpose is needed to maintain profits at a high enough level to finance the huge and continuing expansion of our industrial machine that is now underway.

Basic Issues

As soon as the amendment was enacted, the President asked Congress to revise the law again. The heart of his proposal was to restore to the Administration the powers it used last spring to arrange the squeeze on profits outlined here.

This controversy will continue. There can be no final answer to it as long as we have the economic controls made necessary by mobilization.

But if we look beneath the surface of this technically complicated controversy, we shall see clearly that the basic issues are:

1. Whether we really shall make an effort to distribute fairly the burdens of inflation caused by our defense mobilization—

2. Whether farmers and organized workers should be exempted from these sacrifices by escalator clauses—at the expense of the nation as a whole—

3. Whether profits should be squeezed still more—at the risk of putting a fatal squeeze on the effort of industry to build new plants and install new tools. These new facilities are essential to maintaining American living standards—and they are the heart of our ability to defend ourselves and the rest of the free world.

Americans face no more important economic issues at this time.

McGraw-Hill Publishing Company, Inc.

NEW CATALOGS AND BULLETINS

A Reader Service To Help Keep You Up-to-Date

(1) CONTROL OF pH—The Bristol Co. Bulletin pH1302, 24 pp. Describes full line of recording and controlling instruments for pH, including the electronic dynamaster strip-chart instrument. Specifications on glass and calomel electrodes in several models for immersion and flow uses. Illustrations of pH instruments in various industries.

(2) WHEEL GUARDS—Morrison Products, Inc. Booklet, 4 pp. Completely illustrated with various sizes of drawn steel guards for portable, flexible shaft, and bench grinders. With or without face plate. Adjustable guards available with various wheel exposures.

(3) VACUUM IMPREGNATION—F. J. Stokes Machine Co. Catalog No. 710, 32 pp. Illustrations and description of the process, the equipment used, and applications such as insulation of armatures, capacitors, coils, transformers, thermometers, weatherproofing, and others. Specifications of standard impregnators given.

(4) POROSITY ELIMINATION — Western Sealant, Inc. Booklet, 6 pp. Describes a new process for eliminating porosity in metal alloy castings and fibreglass laminates. Machined tolerances are unaffected. Applicable before or after final finishing coats. Applied to both machined and rough parts. Resistant to wide temperature ranges, chemicals and solvents.

(5) ELECTRONIC TUBES—Milo Radio & Electronics Corp. Booklet, 38 pp. Technical specifications and information on many special purpose electronic tubes used in industrial applications such as: control, processing, production, research, detecting, avionics and others.

(6) NYLON MATERIALS—The Polymer Corp. Bulletin No. 11, 2 pp. Illustrations and description of the use of nylon for bearing material, valve seats, gears, slip rings, alignment tools, and others. Gears offer quiet operation, resistant to wear, and do not need constant lubrication. Nylon used is FM-10001 Polypenco.

(7) WIRE CLOTH DESIGN—Michigan Wire Cloth Co. Manual. Titled "Engineers Manual of Wire Cloth Strainer," the manual is divided into three sections. Discusses type of weave and metal, mesh, shape and construction of strainer, flow rate, fabrication practices, and adapters. Illustrated with the practical shapes used.

(8) AXONOMETRIC DRAWING — John R. Cassell Co., Inc. Booklet, 4 pp. Illustrations of types of Instrumaster drawing equipment made. Available are: isometric 2 angle and ellipse stencil with 27 ellipse sizes; dimetric 2 angle and ellipse stencil with 27 ellipse sizes in either projection. Also, isometric protractor, and hatching stencils.

(9) HARDEST WOOD — Lignum-Vitae Products Corp. Bulletin, 12 pp. Technical data on a hard self-lubricating wood, that is resistant to acids and chemicals. May be substituted for metals or plastics. Engineering data included.

(10) SOLENOID OIL VALVES—Hauck Mfg. Co. Catalog 710, 2 pp. Describes solenoid valves for shut off on oil pressures up to 350 psi, heavy grades as well as light fuel oils, oil temperatures up to 250 F, and both VL and FM approval. Shows rotating cam feature that clears away foreign matter to provide complete shut-off of oil.

(11) ELECTRIC WIRE INSULATION—Insulation Manufacturers Corp. Bulletin 250 A, 8 pp. Descriptive information and technical data on Dieflex tubings and sleevings. Used to insulate leads and wires in all types of electrical equipment. Types covered are three having cotton, rayon, or glass base braids with oleoresinous varnish, vinyl resin, or silicone varnish treatments. Covers performance, specifications, sizes.

(12) GRINDERS — Mattison Machine Wks. Catalog 1901RM, 20 pp. Gives brief description of each machine, plus an illustration and specifications of each. Machines covered are: rotary type surface grinders, with from one to five spindles; vertical spindle reciprocating surface grinders; traveling wheel face grinders; and types of disk grinders.

(13) GAS CONTROL EQUIPMENT—The Vapor Recovery Systems Co. Bulletin CP2001, 32 pp. Describes Varec tank venting equipment. Illustrations, engineering drawings, and cutaway views of equipment for tanks, gas control, and safety devices for the safe handling and conservation of combustible or toxic liquids.

(14) WELDING ELECTRODES—The International Nickel Co., Inc. Booklet, 19 pp. Reprinted from the Journal of the American Society of Naval Engineers, this booklet contains 33 illustrations, diagrams and charts of Nickel-Molybdenum-Vanadium alloy steel shielded arc welding electrodes of the low hydrogen type. One hundred percent joint efficiency produced.

(15) PYROMETERS — The Bristol Co. Bulletin P1244. Information on a line of millivoltmeter type indicating pyrometers and pyrometer controllers for temperatures up to 4,000 F. Illustrations of wall, switchboard, flush panel mounting, and portable pyrometers. Information on controllers for use with gas, electric, and oil fired furnaces.

(16) CASTINGS—Meehanite Metal Corp. Bulletin No. 34, 4 pp. Gives a number of case histories of unusual applications of the castings in various industries. Engineering characteristics given on cast 1.2 in. bar. Some figures are for before and after heat treatment.

(17) HIGH VACUUM EQUIPMENT — Research Vacuum Supply Co. Catalog 11K, 40 pp. Illustrations and description of equipment such as research high vacuum equipment, high vacuum pumps and oils, gages, glass working machinery. Also included: a full line of hand fires; torches; blast burners; needlepoint burners and other supplies for glass blowing.

(18) THIN ELECTRICAL STEELS — Armco Steel Corp. Catalog, 34 pp. Illus-

HOW TO ORDER—To request more information on any advertised item, jot down the page number of the ad and the initials of the advertiser. For new bulletins, circle the numbers.

PRODUCT ENGINEERING Not good after 1/1/52

Please send complete information about the products advertised on the following pages:
(Use initial of company if more than one advertisement appears on the page)

....

....

....

Send copies of the new bulletins and catalogs circled below to my attention.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49

Name..... Title .....

Company.....

Address..... 11/51

Postage Will be Paid by McGraw-Hill Pub. Co.

No Postage Stamp Necessary if Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 64, (Sec. 34.9, P. L. & R.) New York, N. Y.

Reader Service Manager
PRODUCT ENGINEERING
330 West 42nd Street
New York 18, N. Y.

trations, new test data, and information on thin electrical steels to aid in selection of electrical steels for high frequency equipment. Contains 21 pages of curves giving the magnetic properties of three iron-silicon alloys, specially processed to meet high permeability requirements. Curves show core loss, a-c permeability, induction versus frequency, and exciting rms volt-amp per lb.

(19) COMPARATOR GAGES — Moore Products Co. Bulletin 8004, 24 pp. Completely illustrated with the types of pneumatic comparator gages, and equipment available. Describes operating principle, quality control, calibrated dials for ranges of 0.0014 in. and less, calibrated dials for ranges of 0.003 and more. Includes cross sectional views and graphs.

(20) AUTRONIC CONTROL SYSTEM—The Swartwout Co. Bulletin A-701, 4 pp. Illustrated with photographs, line sketches, dimensional drawings, and a schematic diagram showing principle of operation of this all-electronic system for controlling pressure, temperature, flow and level.

(21) PACKAGED POWER — General Electric Co. Bulletin GEA-5600, 22 pp. Outlines methods of obtaining electric power equipment for quick expansion with a minimum of critical materials. Containing photographs and diagrams, it stresses use of packaged electrical units.

(22) HEAT TREATING AMMUNITION —Surface Combustion Corp. Bulletin SC-153, 4 pp. Describes the fuel-fired batch and continuous furnaces used in the production of small caliber ammunition. Heat treat furnace equipment required at each step in the production of a finished round of ammunition. Has reference tables of temperatures for each step.

(23) TANTALUM CAPACITORS—P. R. Mallory & Co., Inc. Bulletin, 4 pp. Designed for continuous operation over a temperature range of from —60 C to +200 C. Made in two basic cell sizes. Tantalum disk and porous tantalum form the anode, and is housed in silver lined steel shell with electrolyte cathode. Table of specifications for various capacitors.

(24) PLASTIC INSULATED CABLE—Union Carbide & Carbon Corp. Bulletin 54, 16 pp. Describes the use of Bakelite Polyethylene, and Vinylite vinyl chloride elastomeric plastics for covering of cables and wires used in the chemical industry. Both have good mechanical and electrical properties, and offer good chemical inertness.

(25) NICKEL PIPE AND TUBING—The International Nickel Co., Inc. Bulletin T-17, 27 pp. Details on the fabrication and design of nickel and high nickel alloy pipe and tubing. Contains drawings, photographs tables and curves on mechanical physical properties, ASME code requirements, and welding procedures.

(26) BRASS NUTS—Fischer Special Mfg. Co. Catalog, 14 pp. Contains listing of brass parts such as hex nuts, full and jam nuts, machine screw nuts, cap nuts, knurled nut, spark plug terminals, and others. Has illustrations, engineering drawings and complete specifications.

(27) DIFFERENTIAL CONVERTER — Minneapolis-Honeywell Regulator Co. Catalog 2281, 12 pp. A mercury-less flow meter for flow control and range change adjustment from 0-20 to 0-200 in. of water. Operating principles covered, as well as construction features, applications and specifications. Illustrated with typical installation set ups.

(28) AIR CYLINDERS—Rivett Lathe & Grinder, Inc. Catalog Section 55, 12 pp. Completely illustrated with cutaway views, and engineering drawings, it covers the double acting, non-rotating type of cylinder. Specifications given on seven types of cylinders: the clevis, rabbet, center-line, foot, trunnion, blind end flange, and rod and flange.

(29) STEAM TRAP SELECTOR — Yarnall-Waring Co. Bulletin T-1750, 18 pp. Details on all types of traps made by this company with advice on what type to use with various processes. Complete specifications given on all sizes.

(30) INDUSTRIAL CORK PRODUCTS—Dodge Cork Co. Bulletin, 4 pp. Describes characteristics and uses for cork compositions and natural cork. Includes tables giving physical properties of both types, sheet sizes. Illustrations of various products.

(31) SPECIFICATION FINISHES — Egyptian Lacquer Mfg. Co. Booklet. Lists the U. S. Government specification code no., gives complete ingredient detail, and shows drying periods required between applications. Has almost all U. S. Government specification finishes.

(32) PRECISION BALLS — Industrial Tectonics Inc. Bulletin 511, 2 pp. A listing of standard and special balls available in cemented carbides, synthetic sapphire, steels, ceramics, plastics and other materials in sizes 1/32 in. to 4 inches. Tolerances as low as 0.000010 inch.

33 MOTOR CONTROLS — The Clark Controller Co. Catalog, 88 pp. Called the "Controlog", this book is a digest of motor controls. Well illustrated, it has essential information on a line of a-c and d-c motor starters, control centers, contactors, relays, and other accessories.

(34) ALUMINUM REDUCTION — Reynolds Metals Co. Booklet 4475, 16 pp. Illustrations and descriptions of production of aluminum pig by the electrolytic reduction process. Shows large engine-generator plant with 70 engines driving d-c generators. Also production of carbon electrodes.

(35) VIBRATING SCREENS—Link-Belt Co. Catalog 2377, 20 pp. Illustrated booklet on the model UP vibrating screens for high speed separation of solids from liquids. With single or multiple decks, semi or totally enclosed steel housings. Dimension tables, efficiency curves, horsepower requirements.

(36) MICRO PRESSURE SNUBBER — Chemiquip Co. Bulletin, 2 pp. Describes use of pressure snubber to protect gages from shock, and harmful solids. Smooths out pressure fluctuations. Illustrations, cutaway views and specifications. Available in ¼ and ½ npt.

(37) ALLOY STEEL TUBING—Babcock & Wilcox Tube Co. Bulletin TDC 141, 4 pp. Has condensed data on microstructure, critical points, effect of alloy elements, forging, machining, welding, and thermal treatment for 14 well-known alloy steels used in production of tubular parts.

(38) CONVEYOR IDLERS—Chain Belt Co. Bulletin 51-81, 42 pp. Illustrations and information on Rex belt conveyor idlers and machinery. Information on the return belt training idler, and the steep-angle troughed belt idler. Specification and engineering drawings.

(39) LUBRICATION IDEAS — Fiske Brothers Refining Co. Data Book 1-51, 55 pp. Gives complete data on the grades of Lubriplate produced. Contains a complete list of the grease and liquid type with worked penetration temperature, the worked N.L.G.I. no., the melting point, color, waterproofing qualities. Also has recommendations for lubrication for more than 20 industries.

HOW TO ORDER—To request more information on any advertised item, jot down the page number of the ad and the initials of the advertiser. For new bulletins, circle the numbers.

Postage Will be Paid by McGraw-Hill Pub. Co.

No Postage Stamp Necessary if Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 64, (Sec. 34.9, P. L. & R.) New York, N. Y.

Reader Service Manager

PRODUCT ENGINEERING

330 West 42nd Street

New York 18, N. Y.

PRODUCT ENGINEERING Not good after 1/1/52

Please send complete information about the products advertised on the following pages:
(Use initial of company if more than one advertisement appears on the page)

.....

.....

.....

Send copies of the new bulletins and catalogs circled below to my attention.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49

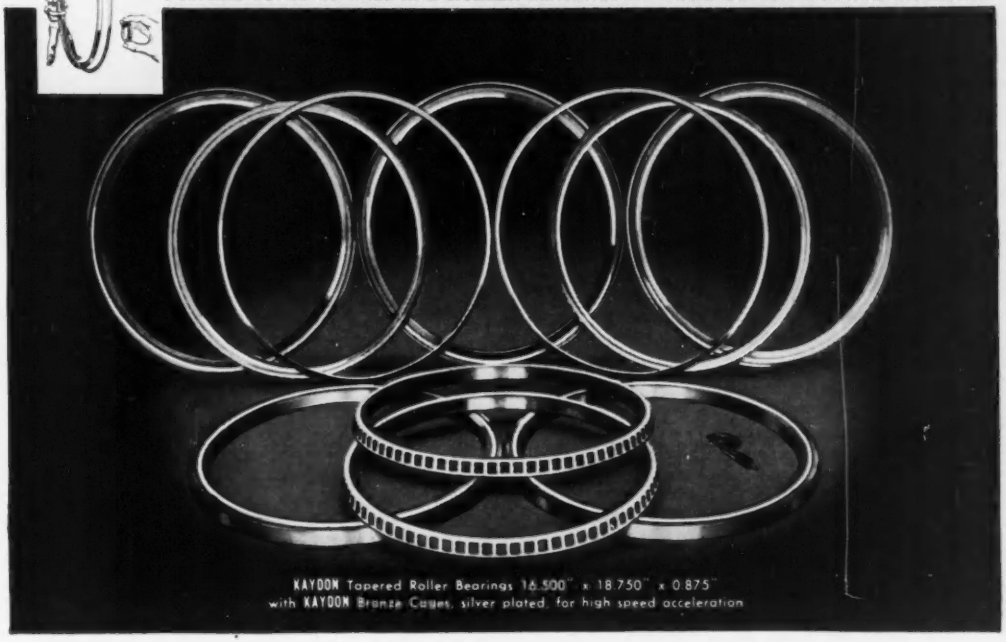
Name ..... Title .....

Company .....

Address 11/51

Contact KAYDON Muskegon

FOR ALL TYPES OF BALL AND ROLLER BEARINGS: 4" BORE TO 120" OUTSIDE DIAMETER



KAYDON Tapered Roller Bearings 16.500" x 18.750" x 0.875"
with KAYDON Bronze Cages, silver plated, for high speed acceleration

Safe Way to Reduce Weight

Look again at this thin section bearing. **KAYDON** bearings like these, designed with very thin section, are a boon to design engineers who recognize weight-reduction and greater precision as prime problems today.

KAYDON Thin-Section Tapered Roller, Straight Roller, and Ball Bearings are helping solve such problems. All types can be made unusually light in weight, and permit much more compact machine design.

Unique high precision techniques that hold to closest tolerances in bearings as large as 120 inches outside diameter, assure consistent accuracy in all types and sizes of **KAYDON** bearings and needle rollers.

★ ★ ★

For your precision bearing requirements, contact **KAYDON** of Muskegon.

KAYDON Types of Standard and Special Bearings:
Spherical Roller • Taper Roller • Ball Radial • Ball Thrust
• Roller Radial • Roller Thrust • Bi-Angular Bearings

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

PRECISION BALL AND ROLLER BEARINGS

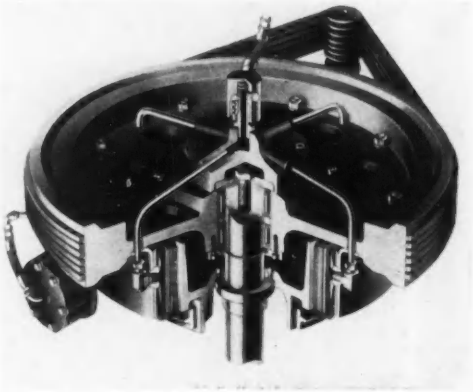
Air Friction Clutch and Air Brake Combination

A new Airflex Air Friction Clutch and spring and air applied brake combination has been developed that offers interlocking clutch-brake action, long, maintenance free life, and increased operator safety.

Developed for use with a line of Press-Rite power presses, the clutch and brake are both of the constricting drum type, and therefore utilize centrifugal force to assure instant disengagement of friction surfaces when released. The brake is applied by a constant pressure spring opened and released by air and its actuation opens a valve to release air from the clutch. Interlocking of clutch and brake action prevents either from being engaged while the other is operating. If air or electric power fails, the clutch disengages and the spring brake stops the press.

Wear is limited to clutch and brake shoe linings which are self-compensating for wear. Seal-packed flywheel bearings and interlocking clutch-brake action reduce wear to a minimum. This new clutch is designed for simplicity and can be removed for inspection easily. There are no adjustments necessary.

Variable clutch gripping pressure permits the operator to set clutch grip for every job, thus helping to avoid injury to operator or damage to dies and press in the event of dies jamming. The clutch is designed for optimum efficiency at pressures from 40 lb to 80 lb, and will operate satisfactorily at as low as 25 lb. The 360 deg contact of friction



surfaces provides full operating power for a given clutch gripping pressure. The new clutch-brake arrangement is now available as optional equipment with the No. 3-30 ton and No. 85—85 ton presses in the Press-Rite line.

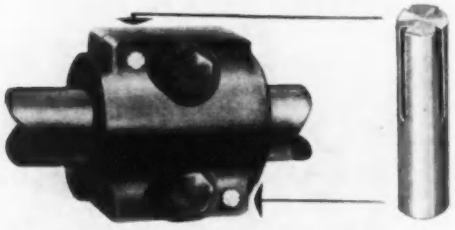
Sales Service Machine Tool Co., 2363 University Ave., St. Paul, Minn.

Lock-Pin Resists Shock and Vibration

Lok Dowels, a precision grooved pin, is said to provide a simplified method of establishing and retaining accurate alignment between component parts of any mechanical device, machine components, dies, jigs and fixtures.

Standard Lok Dowels are made of cold drawn steel, centerless ground and polished. Four parallel grooves impressed along half the length of the Lok Dowel displace a carefully determined amount of metal to each side of the groove. No chip is removed. When the Lok Dowel is forced into a hole, the crests of the eight flutes are forced back into the grooves, but the resiliency of the metal sets up outward radial forces that securely lock the grooved portion of the Lok Dowel in place. Lok Dowels are immune to shock and vibration and will not slip or drop out under hard blows or continuous vibration.

Disassembly and reassembly of any part is fast, because the grooved portion stays in place, while the ungrooved end of the pin is easily slipped out of its part. For installation, the mating parts are clamped or fastened in the



desired position, a slightly under size hole is drilled to proper depth, reamed to precise size and the Lok Dowel, which is also made of drill rod, is pressed or driven into place.

Driv-Lok Pin Co., Sycamore, Ill.

A NEW RESIN PAINT INGREDIENT, called Cycopol 5203-5, has been developed which contains no castor oil. Produced to meet military requirements for a fast-drying, durable finish for ammunition, the resin may be used in a variety of air drying and baking applications. The manufacturer claims rapid drying, with good color, and gloss and valuable film properties. American Cyanamid Co., 30 Rockefeller Plaza, New York, 20, N. Y.

A NEW ALL-PURPOSE LUBRICANT of the Bentone type is being produced in grades from No. 00 to No. 3. These lubricants offer complete stability under all service and storage conditions, and retain good lubricating characteristics under all temperature conditions. They will absorb moisture without losing their lubricating qualities. Hood Refining Co., 553 S. Pennsylvania Ave., Greensburg, Pa.

CONTINUED ON PAGE 234

See your CRANE Catalog first...
And get all the piping data you need

All the piping data you need means simply this: information about every item in your Crane Catalog is complete. When you check on a valve or fitting, you get a complete rundown on its dimensions; tabulated pressure and temperature ratings; design, material, and construction details; plus a full listing of recommended services.

In addition, there's a wealth of general engineering data to help you solve problems that come up in designing piping systems. And not to be overlooked—*especially today*—is the added value the name Crane gives your product. Veteran machinery buyers know that Crane Quality means utmost dependability—that Crane-equipped machines stand up better under today's heavier work loads.

FOR PROCESS FLUIDS

of many kinds and for a wide range of fluids corrosive to iron but non-active chemically upon neoprene—also for services where abrasion is a destructive factor—Crane recommends No. 1615 Neoprene-Lined Iron Body Diaphragm Valves. Sizes: ½ to 6 inches. See your No. 49 Crane Catalog, pp. 106-7.

FOR AN UNEQUALED SELECTION OF QUALITY PIPING MATERIALS . . . LOOK TO THE BROAD CRANE LINE

Vertical Plate Filter For Acid Plating Solutions by Belke Manufacturing Company, Chicago, Ill.

CRANE CO.

General Offices:
836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

Multiple Deck JA Type Rotary Selector Switch

A revised line of type JA Rotary Selector Switches has been announced for applications requiring a large number of contact points with multiple desks. The manufacturers claim that the switches have: long life; electrical stability; ability to withstand severe vibration and shock tests; and wide versatility in application.

The switch is water tight with an "O" ring seal on both shaft and mounting bushing, and is designed to withstand the corrosive action of tropical salt spray. The indexing mechanism has beryllium copper cam and roller arms with case hardened steel rollers, stainless steel shaft, and brass base plate. Stationary contacts are silver 0.004 m. thick overlay on bronze. The rotary contacts have dual beryllium copper contact arms with solid silver contacts forming two independent circuits. Contact resistance is an average of 0.0025 ohms, with a max. of 0.005 ohms. The breakdown voltage is above 2,500 v rms. The switching function has a 16, 24 or 30 position. Two deck is standard. The mounting arrangement provides a single hole with a locating pin, and a panel thickness up to $\frac{1}{8}$ inch. Electrical rating is: continuous 125 v a-c 25 amp load or 28 v d-c 25 amp load.

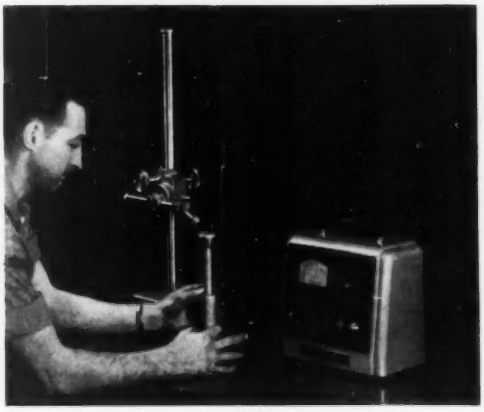
U. S. Instrument Corp., 409 Broad St., Summit, N. J.

Electronic Height Indicator Gives Quick Reading

A new type of electronic height indicator has been designed for use in the toolroom and for receiving, process and final inspection where highly accurate measurement is desired from a surface plate reference. Measurements may be taken from above or below a surface without reversing the clockwise movement of the indicator hand from the minus to the plus side of zero on the scale.

An electronic gage head with dual 1,000/2,000 to 1 amplification, smallest graduation 0.0001 in., a balanced scale of plus and minus 0.0015 in. and 0.003 in. respectively, gives a quick positive and accurate reading. The gage has a vertical capacity of 0 to 26 in.; throat capacity-gaging point to edge of base $3\frac{1}{2}$ to 10 inches.

An adjustment knob on top of the pickup unit, provides a maximum adjustment of 0.010 of the gaging stylus. The mounting bracket is adjustable vertically on the column to any point within an 18 in. range by means of a rack and pinion. The extension arm can be adjusted horizontally to bring the pickup head to any point $4\frac{1}{2}$ to 11 in. from the column. It is also adjustable radially within a range of 345 deg. The pickup head can be rotated and locked in position at any point within a full range of 360 degrees.



The Sheffield Corp., Springfield & Thomas Sts., Dayton 1, Ohio

NEW SMALL BEARINGS measure $\frac{3}{32}$ in. bore x $\frac{5}{16}$ in. O.D. x $\frac{7}{64}$ in. wide, in tolerances ABEC 5 and higher. Features are low and uniform values of starting or breakaway torque, a high percentage falling in the range 0.0006 in.-oz under a standardized 75 grams thrust load. Individual stainless steel coil springs serve as separators. Rings and balls are standard in high-carbon chrome steel. New Hampshire Ball Bearings, Peterborough, N. H.

A NEW PNEUMATIC TEMPERATURE CONTROL and high temperature safety cut off has been developed which offers a temperature range of sub zero to 2,000 F. Tube expansion is transmitted to the pilot valve, which handles 15 lb and pressure direct. A motion of 0.005 in.-0.006 in. moves the pilot valve from fully open to fully closed. Burling Instrument Co., 5 Vose Ave., So. Orange, N. J.

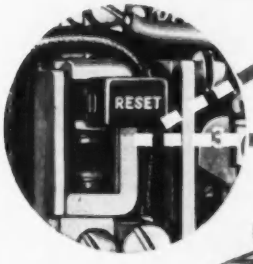
CONTINUED ON PAGE 236

NEW!

R-B-M

A. C. MAGNETIC STARTERS

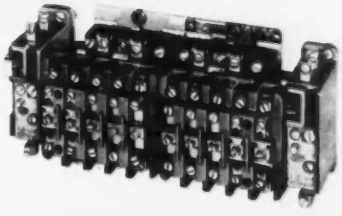
Line Voltage Type



With Visible Contact Overload Relays

- Heater element cannot be assembled to starter incorrectly.
- Bi-metallic thermal overload relay assembly replaceable without removing starter from enclosure. Designed for separate mounting without subpanel assembly.
- TRIP-FREE Manual reset is standard. Manual-Automatic Reset available on special order at no extra cost.

Two 5 pole contactors mechanically interlocked with overload protection on common base. Unwired. Note interchangeability of 25 ampere normally open contacts and 15 ampere convertible N.O. or N.C. interlocks.



R-B-M Size 0 and 1 A.C. Magnetic Starters have identical overall panel mounting dimensions. All parts, except stationary and movable contact assemblies, are common to both sizes.

Ilsco solderless lugs, suitable for #6 maximum wire size, are standard. Screw terminals are available on special order. Magnet coil can be removed without disassembling starter. Stationary and movable contacts replaceable without disconnecting wiring. Enclosed heater element, expanding U-shaped bi-metal and snap action contact mechanism provide dependable, accurate motor overload protection.

Small overall size, plus identical mounting dimensions for 10 and 15 ampere 2 to 5 pole contactors, as well as Size 0 and 1 non-reversing starters, make the R-B-M line extremely flexible for control panel layout.

Address Department C-11

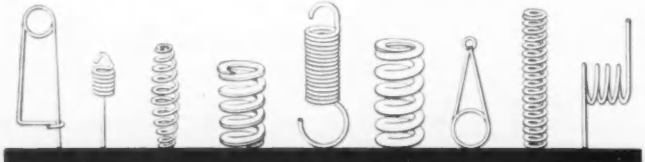
R-B-M DIVISION ESSEX WIRE CORP.
Logansport, Indiana

MANUAL AND MAGNETIC ELECTRIC CONTROLS — FOR AUTOMOTIVE, INDUSTRIAL, COMMUNICATION AND ELECTRONIC USE

. . . and we've had it for more than 60 years . . . a burning ambition to make constantly better springs.

As long-time specialists in hot or cold wound springs, our engineers are often instrumental in helping people like yourself improve product performance and reduce production costs. Our old customers (and we hope you will become one) have learned to look to No. 2 John Street as a thoroughly reliable and unusually prompt source of supply.

AMERICAN-FORT PITT SPRING DIVISION
H. K. Porter Company, Inc.
No. 2 John Street, McKees Rocks, Pa. (Pittsburgh District)

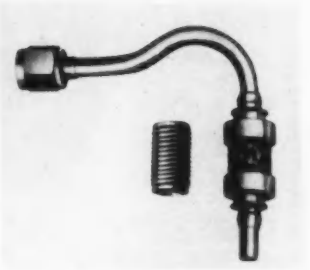


AMERICAN-FORT PITT SPRINGS

Flexible Manifold Connection For Jet Engines

To overcome the effects of increasingly high temperatures in jet engines, a new stainless steel flexible fuel oil manifold connection has been developed which employs bellows as the flexible element.

The stainless steel bellows is welded to the fuel oil tubing and then covered



with a metallic braid to give mechanical protection to the assembly. This bellows permits leakproof assembly of flare fittings and accommodates slight misalignments by providing flexibility in the tubing connections from the manifold. Its flexibility also permits the over-all assembly to adapt itself to dimensional changes caused by thermal expansion. Furnished in $\frac{1}{4}$ in. and $\frac{3}{8}$ in. tubing, it has a pressure rating of 1,000 psi.

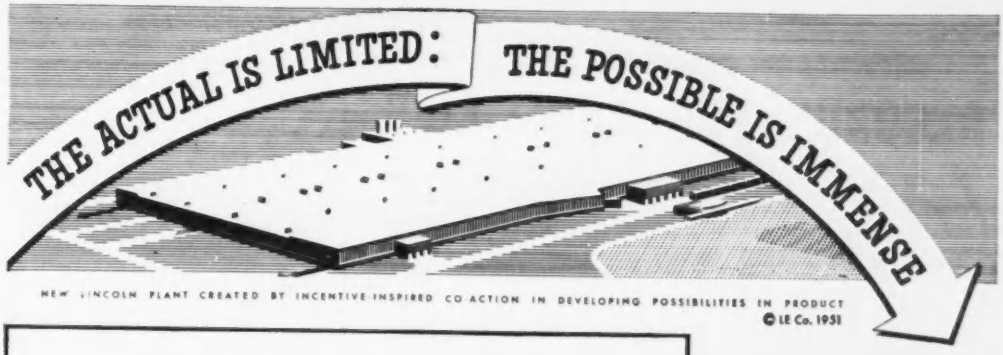
Clifford Mfg. Co., Waltham, Mass.

Self Locking Bolt Requires No Nuts

A new slotted-type place bolt requires no nuts, washers or other devices to lock against vibration when drawn up against a rigid seat.

Cold-headed place bolts are fully reusable, one-piece and all-metal, and can be made of carbon as well as alloy steel. They are available in a range of American Standard sizes from $\frac{1}{4}$ to 1 in., in coarse or fine thread pitches.

The place bolt's spring-action head not only establishes the locking action but also insures against fatigue, impact or shock failures. Upset slots across the top of the head divide it into six equal segments. Upset operation also forms a narrow circular recess under the head, next to the shank. The bearing area is the surface under the head, outside the recess. As the bolt is drawn up, the upward pressure on the bearing area slightly displaces the



NEW LINCOLN PLANT CREATED BY INCENTIVE-INSPIRED CO-ACTION IN DEVELOPING POSSIBILITIES IN PRODUCT

© LE Co. 1951

STEEL IS TWICE AS STIFF

. . . achieves equal rigidity with half the material

CONTRARY to erroneously preconceived notions, steel is twice as rigid as iron. In the simple demonstration shown in Fig. 3, a bar of steel deflects only half as much as a bar of iron stressed under equal load.

When designing a machine component for equal stiffness with steel, weight generally should be cut 50% or more. Otherwise, the design has not been developed far enough to fully utilize the superior physical properties of steel.

Welded steel has several additional benefits that improve product durability. Steel is 3 times stronger . . . has four times the resistance to fatigue. Steel is also ductile . . . withstands impact and shock without fracturing.

Your Lincoln Welding Engineer will gladly demonstrate how to apply these basic, cost-saving advantages to your products. Write The Lincoln Electric Co., Cleveland 1, O.

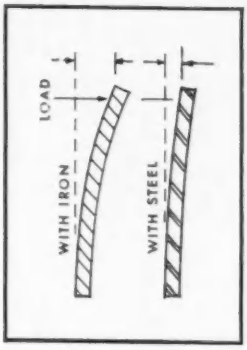


Fig. 3—Steel deflects only half that of iron *under equal loading. 50% of the material is generally required to duplicate stiffness.*

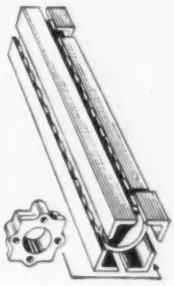


Fig. 5—Maintains alignment *to within .005" on this 120" long machine frame member. Machining time was cut from 8 hours to 2¼ hours and 170 pounds of metal saved on each frame member.*

Fig. 4—Design in steel cuts deflection 80%. *Originally the top for this planer deflected .070". With the present, welded steel construction, the deflection is only .014". Weight has been reduced from 410 pounds to 320 pounds.*

WELDED DESIGN ALWAYS IMPROVES PRODUCT AND LOWERS COST

Welded Steel Design

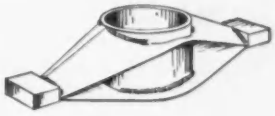


Fig. 1—Increases Rigidity 200% *by redesigning this End Bearing Bracket to welded steel. Cost is cut from $1.52 to 75 cents over construction shown in Fig. 2 . . .* a saving of 51%.

Original Design

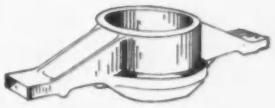


Fig. 2—Original Construction *required 87% more metal than present welded steel design. Initial weight was 3¼ pounds . . . welded steel design (Fig. 1) weighs only 2 pounds.*

HERE IS PROOF

Machine Design Sheets are available to designers and engineers. Simply write on your letterhead to Dept. 310,

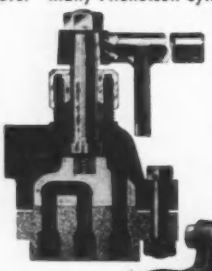
THE LINCOLN ELECTRIC COMPANY

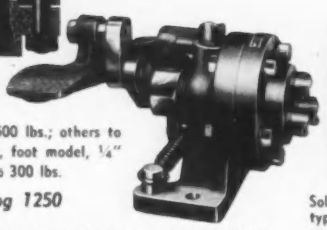
CLEVELAND 1, OHIO

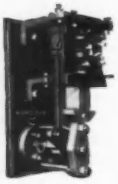
NICHOLSON CONTROL VALVES SET

RECORDS FOR LONG LIFE

In a wide range of plants—steel, metal working, processing, etc.—many Nicholson cylinder control valves have now been in continuous service for over 25 years. Their capacity for long leak-free service is confirmed by repeated installation records showing Nicholson valves actually become tighter with use. This is because their non-corrosive flat discs tend to lap themselves on the seats. For air, gas, oil, steam, water.







Above, lever model, ¼" to 2½", press. to 500 lbs.; others to 5000 lbs. Right, foot model, ¼" to 1½", press. to 300 lbs.

Catalog 1250

Solenoid and motor types, ⅛" to 2½"; press. to 375 lbs. Many metal combinations.

W. H. NICHOLSON & CO. 200 OREGON ST. WILKES-BARRE, PA.

Sales and Engineering Offices in 53 Principal Cities

It's a special kind of finish which cannot be described or pictured — but it's different from the finish on any other tracing cloth. It feels different, it inks different, it erases different — it's tougher, more uniform and differently better. That's just a claim — but with a little cooperation from you we can prove it. Just write for samples and test them — that's all. Others have and that is why so many are using Micro-Weave Tracing Cloth. Why don't you try it?
A HOLLISTON MILLS PRODUCT
Micro-Weave All American TRACING CLOTH
White or Blue for Ink or Pencil
PEL-X

THE HOLLISTON MILLS, INC.
NORWOOD, MASS.
NEW YORK PHILADELPHIA CHICAGO

MICRO-WEAVE is backed by Holliston's 50 years of leadership and experience in developing special cloths for industry.

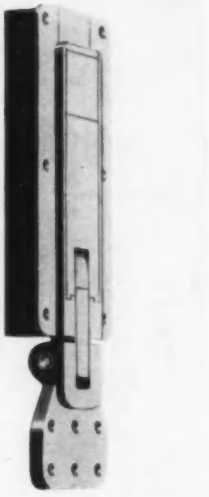
segments on top of the head, to effect the diaphragm spring action (section X).

Grain flow is continuous through shank and head segments for maximum strength, and the shear section of the head is stronger than the mean equivalent area of the thread. The place bolt as a result is said to be capable of carrying a load equivalent to that of a conventional bolt or cap screw.

The National Screw & Mfg. Co., 2440 E. 75th St., Cleveland 4, Ohio

Heavy Duty Access Latch

This heavy duty, all purpose, access latch is a toggle type unit offering positive locking, flush fitting and simplicity in operation. Each latch has two



basic units; a housing and a toggle assembly, with no loose parts. It is designed for flat panels, use on cargo doors, radomes, and compartments. Weighing 3.5 oz, it will carry up to 2,700 lb in tension and 5,000 lb in shear.

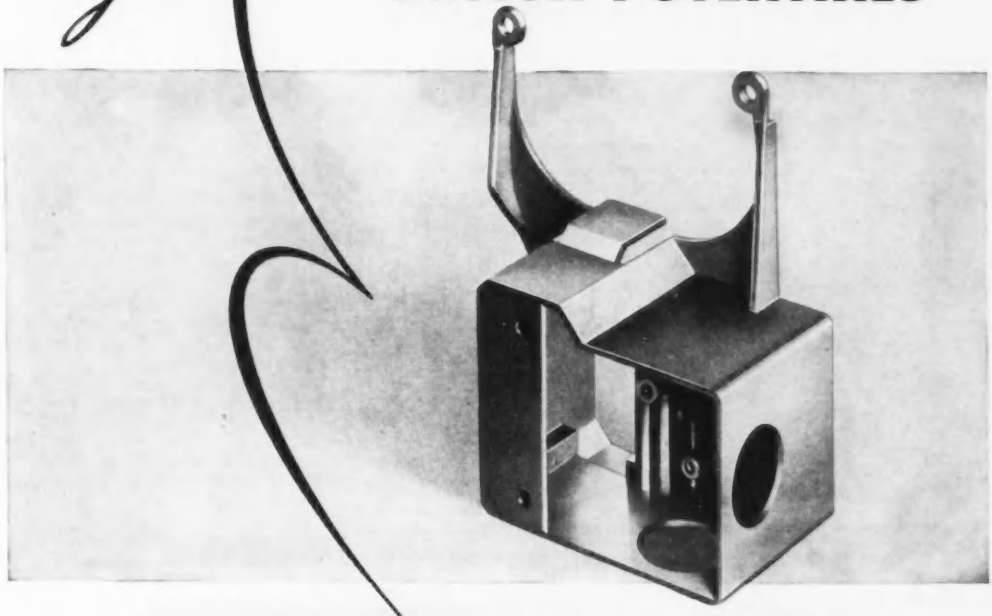
Simmonds Aerocessories, Tarrytown, N. Y.

400 Cycle Timing Motor For Light Loads

A new 400 cycle timing motor has been developed for use as time standard in applications involving relatively light loads.

This new 400 cycle motor is a hysteresis type synchronous timing motor and is designed for use either as a

Flexible DESIGN POTENTIALS



with **MADISON-KIPP** *Zinc and Aluminum* **DIE CASTINGS**

The function and also the position of a component often establish a very irregular shape, like the add-on control here illustrated. The Madison-Kipp die casting process is ideal for producing these "special" shapes and offers the designer great flexibility without cost penalty. Please send all inquiries to our home office in Madison, Wisconsin.

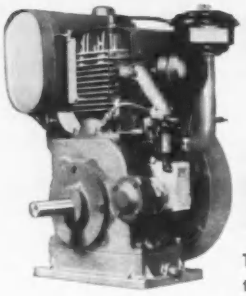
MADISON-KIPP CORPORATION

206 WAUBESA STREET, MADISON 10, WIS., U.S.A.

ANCIENS ATELIERS GASQUY, 31 Rue du Marais, Brussels, Belgium, sole agents for Belgium, Holland, France, and Switzerland.

WM. COULTHARD & CO. Ltd., Carlisle, England, sole agents for England, most European countries, India, Australia, and New Zealand.

- *Skilled in* DIE CASTING *Mechanics*
- *Experienced in* LUBRICATION *Engineering*
- *Originators of Really High Speed* AIR TOOLS



Four Single-Cylinder WISCONSIN *Air-Cooled* ENGINES Offering More POWER ADVANTAGE, 6 to 9 hp.

This series of single-cylinder models have all of the traditional Wisconsin heavy-duty features such as self-cleaning tapered roller bearings at both ends of the crankshaft, rotary-type, high tension OUTSIDE magneto operating as an independent unit, and maximum torque at all usable speeds.

CONDENSED SPECIFICATIONS

MODELS	AEH	AFH	AGH	AHH
Bore - - - - - - - - - inches	3	3¼	3½	3⅝
Stroke - - - - - - - - - inches	3¼	4	4	4
Disp. cubic inches - - - - - - - -	23	33.2	38.5	41.3
H. P. and R.P.M. range - - - - - -	3.9 at 1600	6.0 at 1600	7.2 at 1600	7.7 at 1600
	6.1 at 2600	7.2 at 2200	8.4 at 2200	9.2 at 2200
Net weight in lbs., Standard Engine - - -	130	180	180	180

Our engineering department will gladly cooperate with you in adapting Wisconsin Engines to your requirements. Write for detailed data and name of the nearest Wisconsin distributor.

WISCONSIN MOTOR CORPORATION
World's Largest Builders of Heavy-Duty Air-Cooled Engines
MILWAUKEE 46 WISCONSIN

MAGNETIC AMPLIFIERS INC

MAGNETIC AMPLIFIERS·INC

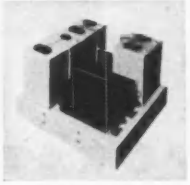
Affiliate of GENERAL CERAMICS & STEATITE CORP.

11-54 44th DRIVE, LONG ISLAND CITY, NEW YORK • TEL. STILLWELL 6-2191

PACKAGED PUSH-PULL MAGNETIC AMPLIFIERS 60 and 400 CPS and higher

SATURABLE TRANSFORMERS AND REACTORS 60 and 400 CPS 1 W to 1 KW

VOLTAGE CURRENT FREQUENCY MOTOR SPEED REGULATORS

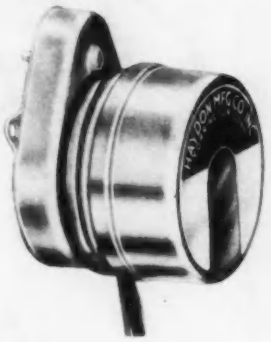


MAGNETIC MODULATORS DEMODULATORS TOROIDAL WINDINGS

AMPLIFIERS AND COMPONENTS FOR:

AIRCRAFT • GUIDED MISSILES • ARMAMENT • NAVAL INSTALLATIONS • ATOMIC ENERGY • INDUSTRIAL CONTROL • RADAR INSTALLATIONS • TEST EQUIPMENT

Write to Us for Engineering Proposals on Your Specialized Requirements



separate component or in a variety of types of standard timers. It is claimed that at any given frequency, control is better than with comparable d-c motors, because variations in temperature, supply voltage and load, within the operational limits of the motor, do not affect timing. Since these motors follow frequency changes, the degree of accuracy is a matter of regulation.

The manufacturer claims that with an a-c motor of this type, R-F filtering or shielding is not required. Concern as to the effect of altitude is eliminated; brush life or wear is no longer a problem. Where the primary current supply is 400 cycle, equipment for rectifying to d-c may be reduced.

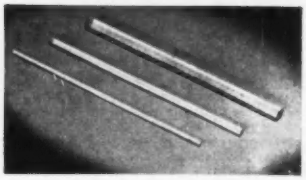
Haydon Mfg. Co., Inc., Elm St., Torrington, Conn.

Plastic Rod Has Good Electrical Properties

A high tensile strength plastic rod, produced in fractional sizes, has good electrical and corrosion resistant properties.

The plastic material has a tensile strength of 100,000 psi, a compressive strength of 70,000 psi and flexural strength is 150,000 psi. Youngs modulus 6 x 10^6. Impact strength perpendicular to axis is 70 lb-ft Izod. Moisture absorption is 0.15 percent and specific gravity, 1.9.

Among electrical properties, arc resistance is 120 sec ASTM, dielectric strength 280 v per mil. Power factor is 2.5. The rods are resistant to acid and mild alkalies as well as to salts



Portion of Mt. Vernon's Tool & Die Shop. Here is every facility for precision work.

DIE CASTING

Dependability is Assured here!

At Mount Vernon, we have completely coordinated designing, engineering and die building facilities *under one roof.* The activities of our modern and extensive die shop are closely integrated with those of other departments, with the result that long-life, accurate dies—yielding clean, flawless castings—are assured.

When considering a manufacturing procedure, therefore, remember not only the outstanding economies inherent in die casting, but also

Mount Vernon's Complete Four-Fold Service

(1) Consultation—M. V. can help you with design and production problems by making recommendations based upon your specific requirements.

(2) Die Making—M. V's up-to-the-minute tool and die shop equipment, plus long experience and highly skilled personnel, assure a dependable source for quality dies.

(3) Castings—M. V. castings, meeting ADCI standards, are guaranteed "on grade" at all times.

(4) Machining—M.V. machining facilities can handle every machining operation that castings may require.

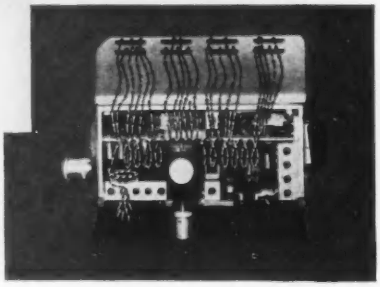
We shall welcome the opportunity to serve, and assist you—as we have assisted many others—to increase your output, improve your products, and *hold down your production costs.*

MT. VERNON
DIE CASTING CORP.
MT VERNON NEW YORK

A CYCLOHM MOTOR

DOES THE JOB

FOR DUMONT



You can tell a motor by the company it keeps!

EMC and CYCLOHM Fractional H.P. Motors

Universal and Direct Current 1/1000 to 1/2 h.p.
Shaded Pole 1/2000 to 1/15 h.p. • **Induction types** 1/1400 to 1/4 h.p.

The DuMont Image Orthicon TV Camera shown above is another triumph of superior engineering skill and know-how that has helped contribute to the fine reputation of DuMont Equipment. An important part of this unit is the Cyclohm 2500 motor which creates a continuous stream of cool air circulating throughout the camera—cooling 40 tubes en route. DuMont engineers chose a Cyclohm motor for its ability to maintain the low ambient temperature in view of the large heat dissipation and for quiet, dependable performance. EMC Universal, Direct Current and Shaded Pole Motors and CYCLOHM Induction Motors are currently being used by DuMont and other leading manufacturers for more than 500 applications—cameras, communications equipment, sewing machines, vending machines, mixers, adding machines, portable power tools, and scores of defense applications. Write today for our new catalog. Be sure to check with Howard on your fractional H. P. Motor Requirements.

HOWARD

DEPT. PE-6 • HOWARD INDUSTRIES, INC. • RACINE, WISCONSIN
DIVISIONS: EMC ELECTRIC MOTOR CORP. CYCLOHM MOTOR CORP.

and most organic solvents. Salt-spray resistance is good.

Among recommended applications are stand-off insulators, tension rods, supports in chemical equipment and structural members in corrosive atmospheres. It is also available in sheet and molded parts.

The Dynakon Corp., 5509 Hough Ave., Cleveland 3, Ohio

Miniature Resistors in Lug Types

A new miniature, hermetically-sealed resistor called the Akra-ohm type 1180 has been designed to meet the requirements of JAN-R-93, characteristic A, style RB11. This resistor, which has

solder lug terminals, is 19/32 in. long x $\frac{1}{2}$ in. dia and is rated 0.25 w at 250 v. Resistance values up to 0.1, 0.3 or 0.4 megohms may be obtained depending on the alloy wire used for the non-inductive winding. The resistor is hermetically-sealed in Steatite by a process which provides immunity against the effects of humidity, fungus and salt water immersion.

Shallcross Mfg. Co., Collingdale, Pa.

Small RF Wattmeters

Two small resistive load RF wattmeters have been developed for use with P-8501 and the P-8501-A test sets also produced by this company. These units may also be used with any 0-50 microammeter.

The Model P-7280 measures RF power output from 0-60 w and is used for testing base stations and mobile unit transmitters. The model P-7208-A measures transmitter power output from 0-2 w and is recommended for portable unit testing, such as the "Handie-Talkie" portable radiophone.

The output of the transmitter tested is fed into the wattmeter load, and a suitable indicating device is connected to the jack provided. The calibration chart supplied is used to correlate the

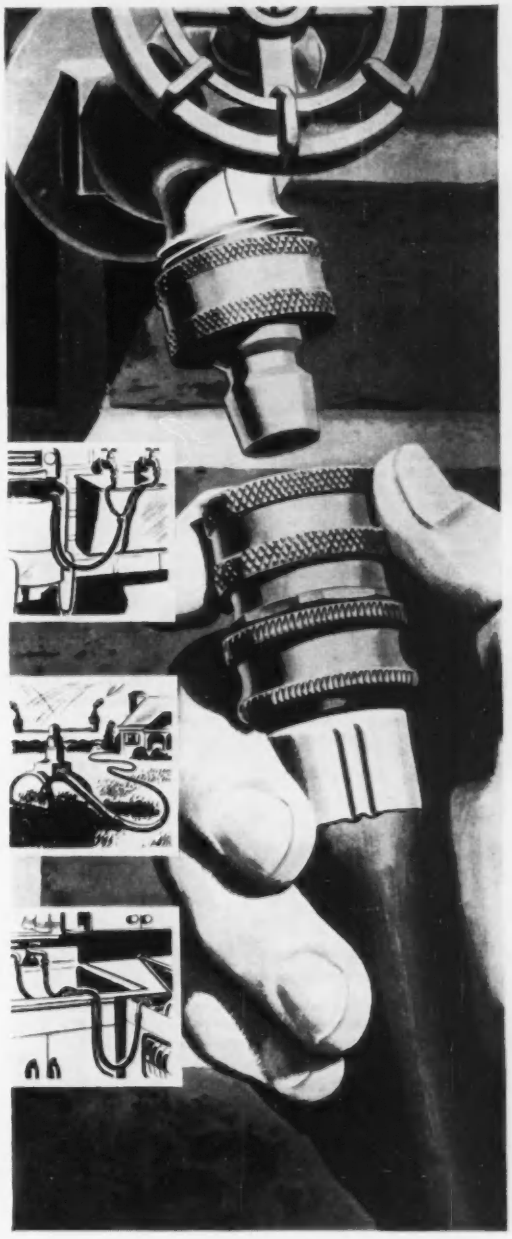
this ***snap-action coupler*** *looks good on paper—*

IT LOOKS EVEN BETTER IN BRASS

Snap-Tite, Inc., Union City, Pa., makes this brass snap-action hose coupler and describes it as "being to hose what a zipper is to clothes." That's a good description of the fast and simple way this coupler snaps together to make a leakproof coupling—even under high pressures. For connecting the garden hose down through a great variety of industrial hose applications, this ingenious coupler is saving time and tempers.

The logic behind making this coupler of brass is based on the properties of this useful, versatile metal. Brass, in the form of ANACONDA Free Cutting Rods, is economical to fabricate by modern screw machine methods. At the same time, brass possesses all the necessary toughness and strength, needs no finishing and, of course, never rusts. Brass gives a product eye-appeal, associates it with solid quality—yet asks no favors in terms of final costs.

If your product can profit by these properties, we would like to send you a copy of Publication B-28. It describes in detail the composition, forms available and physical properties of ANACONDA Copper Alloys. Just write to The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. 51106



ANACONDA® — *the name to remember in*

COPPER
BRASS
BRONZE

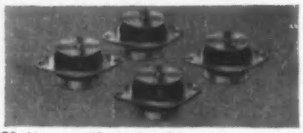
SHOCK and VIBRATION NEWS

BARRYMOUNTS FOR ASSURED CONTROL OF SHOCK AND VIBRATION

SMALL PLATE-TYPE BARRYMOUNTS

for Mounting Light Industrial Equipment

New Series 6300 Barrymounts are designed to fill the need for plate-type vibration isolators requiring little mounting space and carrying light to moderate loads.



Unit mountings in this series can be furnished with load ratings as low as one pound and up to 11 pounds. The free height of the top of the unit mounting, above the central mounting plate, is approximately 23/64 inch. The symmetrical design permits loads to be applied either axially or radially, or with components in both directions.

Designed primarily as vibration isolators, the Series 6300 units have a transmissibility of about 6 at resonance, which occurs at approximately 15 cycles per second under rated load. Vibration isolation at 30 cycles or above is extremely efficient. The stability of the mounting is excellent, and transient shock isolation is satisfactory for the intended service.

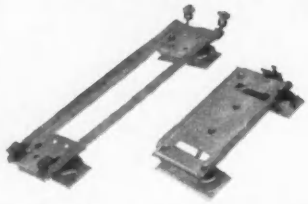
These new Barrymounts are available in two mounting styles: Series 6300, with two holes on 1-13/32 inch centers, and Series 6780, with four holes at the corners of a one-inch square. Detailed ratings, performance data, and dimensions are given on Data Sheet 618. Write for your free copy today!

FREE CATALOGS

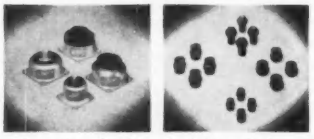
- 502 – Air-damped Barrymounts for aircraft service; also mounting bases and instrument mountings.
- 509 — ALL-METL Barrymounts and mounting bases for unusual airborne applications.
- 504 — Shock mounts and vibration isolators for marine, mobile, and industrial uses.
- 607 — How to cut maintenance costs by using Barrymounts with punch presses.
- 605-606 — Miniaturized air-damped Barrymounts for use with airborne equipment.

STANDARD MOUNTINGS ISOLATE VIBRATION

Available for Aircraft, Marine, Mobile, Instrument, and Industrial uses.



Standard bases built to meet government specifications can be furnished by Barry; special bases can be supplied in sizes and load ratings to fit customers' exact requirements, including miniaturized bases. See catalog 502 and data sheets 605 and 606.



Aircraft vibration isolators designed to meet Army, Navy, and CAA requirements are available in ¼-pound to 45-pound unit ratings; also miniature mounts to 0.1 lb. See catalogs 502 and 509 and bulletins 605-6.

Instrument mountings are furnished for electronic components, tiny, fractional-HP motors, record changers, dictating machines, and other lightweight apparatus. See catalogs 502 and 504.

Shock mountings for mobile, railroad, and shipboard service also give vibration isolation at frequencies above 2000 c.p.m.; useful for general sound isolation. See catalog 504.

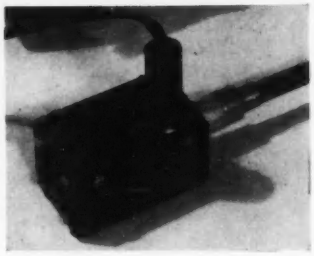
Industrial mountings isolate vibration from fans, motor-generator sets, transformers, punch presses, and other heavy industrial equipment. Bulletin 607 tells how to cut maintenance costs with Barrymounts.

THE **BARRY** CORP.

730 PLEASANT ST., WATERTOWN 72, MASSACHUSETTS

SALES REPRESENTATIVES IN

New York Rochester Philadelphia Washington Cleveland Dayton Detroit
Chicago Minneapolis St. Louis Seattle Los Angeles Dallas Toronto Atlanta



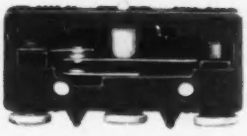
power dissipated in the load unit and the meter readings. A hermetically sealed crystal diode and a 1 percent metalized multiplier resistor are incorporated in the unit.

Motorola Inc., 4545 W. Augusta Blvd., Chicago 51, Ill.

Limit Switch Has Good Contact

As a direct-acting switch, the du.op (dual operation) limit switch has no inherent characteristics of bounce. Once the contact is made, it remains closed. Mechanical lost motion which would delay contact operation is eliminated, because instantaneous contact is made at the same fixed point of repetitive plunger travel. The du.op is said to have a particular advantage in many applications involving precision or electronic timing where snap-action switches would have a varying time delay before actual contact transfer.

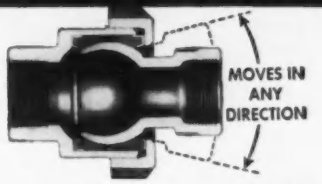
As shown in the illustration, the actuating plunger acts directly on the long contact spring. This arrangement insures contact transfer with maximum spring pressure up to actual make or break. Overtravel has no appreciable effect on the life of the contact member since excessive deflection is prevented. Each of the three contact blades is a solid piece of phosphor-bronze and each blade is directly



BARCO *Flexible* JOINTS *to meet* INDUSTRY'S NEEDS!

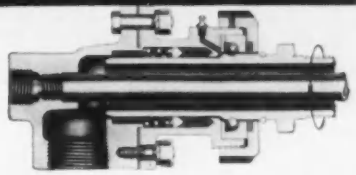
Wherever piping connections must move, look to **BARCO** for the **ANSWER!** Whatever your problem, Barco, invariably, can solve it **BETTER, EASIER,** and **QUICKER** with a tested and proven joint right out of the standard Barco line. This is because Barco builds a truly complete line of flexible ball, swivel, swing, and revolving joints—*there is a size and type for every purpose!* Submit your problem; ask for recommendations—Barco is at your service.

FLEXIBLE BALL JOINTS



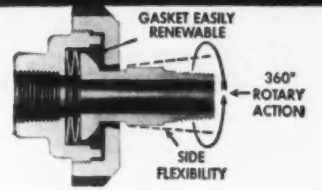
"One *joint does the work of two or more!*"—because it moves in any direction. Standard the world over where low cost, leakproof movable joints are needed in piping handling steam, air, water, oil, gas, or chemicals. Many models available. Up to 40° side flexibility *plus* 360° swivel action. Also used to facilitate quick connection of piping, overcome misalignment. Pressures to 6,000 psi; temperatures to 1,000° F. 15 different sizes, ¼" to 12". *Bulletin 215.*

REVOLVING JOINTS



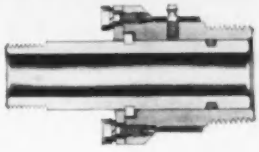
Minimum roll "drag" cuts power costs—up to 50% savings! Note wide spacing between bearings; inherent low torque little affected by pressure, speed, or temperature. Parts easily accessible. Light running action minimizes wear, permits free-floating installation. No adjusting necessary—long, leakproof service. Ratings to 250 psi (steam); 450°F. Single flow or syphon styles. Sizes ½" to 3". Wide choice of models; speeds to as high as 2,500 RPM. *Bulletin 300.*

ROTARY SWIVEL JOINTS



Exclusive angular motion prevents binding—only Barco offers this important advantage! Widely used for making compact, low torque swivel connections to reciprocating or rotating parts on platen presses, tire molds, oil burners. Easy to position piping accurately—no sagging, flopping lines. Leakproof, safe—pressure or vacuum. Ratings as high as 600°F., 3,000 psi (hydraulic). Sizes, ⅜" to 2"; angle or straight. *Bulletin 265.*

SWING JOINTS

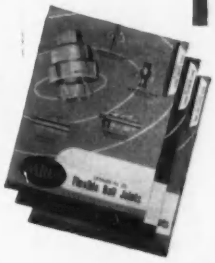


Here is a simple, low cost, precision-built swing joint that is ideal for many applications: oil loading and unloading lines, hose reels, water connections. "O" ring gives leakproof seal. Full bearing surface, swiveling 360° in one plane only, supports normal piping. Built for hydraulic pressures to 500 psi; temperatures, −40° to 225°F. Male or female pipe thread connections, angle or straight. Sizes, ⅜" to 12". *Ask for literature.*

Send for NEW BULLETINS

For detailed information on Barco Joints, write for latest literature:

Bulletin 215: "Barco Ball Joints."
Bulletin 265: "Barco Swivel Joints."
Bulletin 300: "Barco Revolving Joints."
Bulletin: "Barco Swing Joints."



Worldwide Sales and Service

BARCO

MANUFACTURING CO.

1827M Winnemac Ave., Chicago 40, Illinois
In Canada: The Holden Co., Ltd.

The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Revolving Joints

FREE ENTERPRISE—THE CORNERSTONE OF AMERICAN PROSPERITY

TROSTEL QUALITY

3 separate and distinct laboratories control *All* the variables

From raw hides and compounds to final inspection . . . every step in the production of Trostel packings and oil seals is carried on under the watchful supervision of three separate and distinct Trostel laboratories.

This unusually complete control is possible because Trostel performs *all* of the basic pre-production operations in *both* leather and rubber—*more* of them than any other manufacturer.

The end result is a thoroughly tested product based on known operating data . . . one that can be produced economically in quantity . . . to meet the most exacting specifications for quality and dimensional accuracy.

We invite your inquiry.

LEATHER LABORATORY

SYNTHETICS LABORATORY

IMPREGNATIONS LABORATORY

ALBERT TROSTEL & SONS COMPANY
General Offices and Packings Division • Milwaukee 1, Wis.
Sales Offices: Houston • Los Angeles • Worcester, Mass. • San Francisco • Seattle

riveted to a large, threaded, special locking-type brass rivet with a resulting reduction in electrical resistance. The contact arrangement is single pole, double throw, spring return; and will handle up to 20 amp, 125 v a-c, noninductive. The du.op is enclosed in a compact phenolic-molded housing which has the same 1 in. mounting dimensions as snap-action switches, plus other mounting provisions. Equally-spaced and rugged terminals reduce wiring problems.

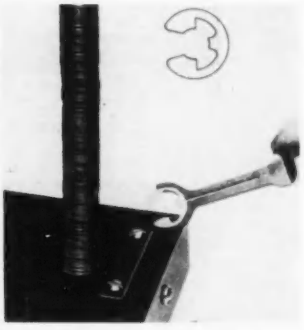
General Control Co., 1200 Soldiers Field Rd., Boston 34, Mass.

Stacked Retaining Rings Eliminate Waste Motions

A new type of stacked, open-type retaining rings have been designed to eliminate the waste motions associated with selecting, untangling and applying unstacked rings.

Offered with these stacked rings is a one-at-a-time dispensing and application method which is said to cut to a fraction the rings' dispensing and application time, and banish all loss of rings through handling. A specially designed base holds the ring stack erect. The retaining rings, are dispensed and applied with one hand and with one continuous motion using the application tool.

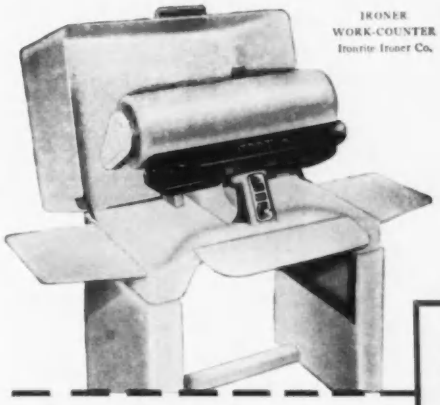
These ring stacks are available at no extra cost to the user than the re-



taining rings themselves. The open-type retaining rings are made from high quality spring steel and provide shoulders on grooved circular shafts. Radially applied and easily snapped into position, these rings replace cotter pins, screw-fastened collars, machined shoulders, nut and washer assemblies and other fastening devices usually requiring machining and assembling.

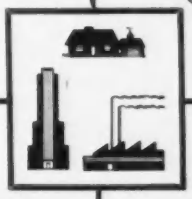
The retaining rings are designed to support heavy thrust loads and to withstand vibrations without displacement. A patented feature offers the added

When you underline LONG, HARD SERVICE

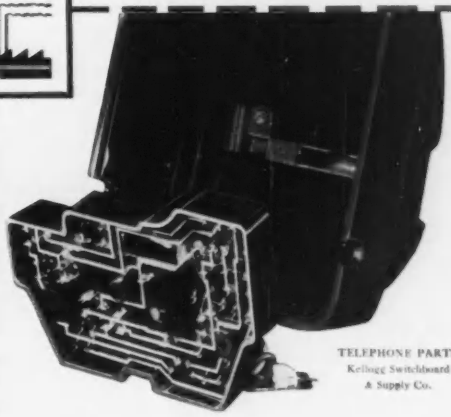


IRONER WORK-COUNTER
Ironrite Ironer Co.

BEVEL GEAR FOR TEXTILE MACHINERY
Industrial Rayon Corp.



CHAIN DRIVE COUPLING COVER
Morse Chain Co.



TELEPHONE PARTS
Kellogg Switchboard & Supply Co.

. . . here's why custom molders suggest DUREZ

This is an invitation to consider using plastics for applications you may have thought of as being too tough for these materials.

If the products or components you make must withstand the destructive effect of impact, tortion, heat, cold, grease, oil, acids, alkalies, or electrical current, Durez phenolics should fit profitably into your plans. These characteristics are available in outstanding degree among the more than 300 Durez molding compounds.

We have developed phenolic compounds that extend the economies of the molding process into many fields of manufacture for rugged service. Economies measurable in faster production, in elimination of machining, assembly, and finishing operations, and in reduced rejection rates, are being won without sacrificing performance.

It will pay you to talk with a custom molder regularly before product plans become "set." He will bring engineering background, modern production facilities, and knowledge of plastics to your problems. For further information and technical assistance, our field staff is at your service.

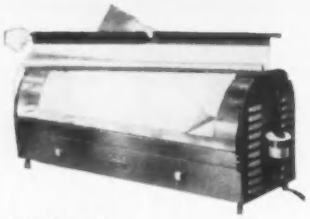
Our monthly "Durez Plastics News" will keep you informed on industry's uses of Durez. Write, on office letterhead, to Durez Plastics & Chemicals, Inc., 2011 Walck Road, North Tonawanda, N. Y.

PHENOLIC PLASTICS THAT FIT THE JOB

Fast, Efficient, Low-Cost

WHITEPRINTERS

for Plant, Lab, Office



SPEE-DEE

Saves up to 80% of Commercial Blue Print Costs!

• Quickly make accurate black-on-white or blue-on-white prints up to 24" x 36" from translucent originals, at less than 2c per sq. ft. Just plug into 115 volt a.c. line. Makes photo-copies too. Uses diazo (moist or ammonia dry) process. $155.81 includes initial supply of paper and developing powder. Printer only, $149.81. Shipping weight, 85 lbs. Smaller models from $55.12. *Order the Spee-Dee on 10-days free trial or write for full facts.*

MODEL "D" VERSA-LINER

Volume Production—Prints when Needed

• Economically prints and develops black line and colored line white-prints. Uses dry ammonia-fume diazo method. Plugs into standard 115 V 60 cycle a.c. line, using 19 amps. Easy to install and operate. Handles cut sheets or roll stock up to 42" wide in any length. Variable speed up to 5 ft. per min. New light source—low replacement cost. Easy to clean. Minimum maintenance. Complete, $1295. Moist diazo-type model at $1095. *Get full facts now.*

PECK & HARVEY

5745 N. WESTERN AVE., CHICAGO 45

Manufacturers of Whiteprint, Blueprint and Photocopy Equipment

advantage of the rings' re-use without loss of resiliency. Substantial savings in dollars and hours are effected by cutting the groove at the same time the shaft is cut, thus eliminating additional machining and assembling operations usually required for other types of fasteners.

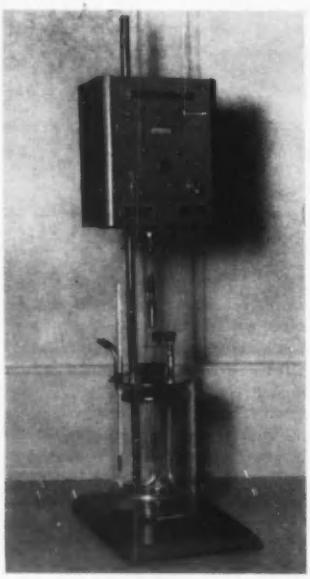
Industrial Retaining Ring Co., 8 W. Sidney Ave., Mount Vernon, N. Y.

Gel-Time Meter Measures Point of Viscosity

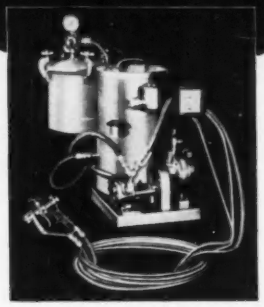
A new gel-time meter has been designed to measure the time required for fluid thermosetting compositions to reach a point of rapid viscosity change during polymerization.

According to the manufacturers, it will be an aid in the evaluation of thermosetting compositions used in the manufacture of monomers, resins, varnishes, and other protective coatings. It can also be used in studying the effects of such variables as reaction temperatures, catalysts, inhibitors, and quality of the main reactants.

The device measures the gel time, a direct function of viscosity drag in the test sample, by means of a rotating spindle suspended from a torsional spring. As the viscosity of the fluid being tested increases, it creates an additional drag on the spindle which is immersed in the fluid. At the gel point, viscosity increases very suddenly and the increase drag on the



SEE HOW GAST explosion-proof ROTARY AIR MOTORS helped solve this problem!



PROBLEM: Specify a motor to drive liquid pump at variable speeds, for Bede Circulating Paint Heater. (A unit for faster, more uniform application of hot finish.)

SOLUTION: A Gast Rotary Air Motor, running below 500 r.p.m., drives pump at 150 r.p.m. Uses less than 30 p.s.i. air pressure.

RESULT: Power that's economical, dependable, safe. With explosion-proof Gast Motor, entire unit was approved by Underwriters' Laboratories.

Your problem may be entirely different — yet the *unique advantages* of Gast Rotaries may offer just what your product requires. In sizes from 1/20 to 3 h.p., Gast Air Motors are amazingly compact and light in weight. And overloads can't burn them out!

Write Gast, describing your original equipment application. We'll send full details. "Air may be your Answer!"

Gast Application Ideas Booklet—showing 26 design problems solved — sent upon request.

SEND OUR CATALOG 69

Original Equipment Manufacturers for Over 25 Years

GAST ROTARY

AIR MOTORS · COMPRESSORS · VACUUM PUMPS

(TO THREE H.P.) (TO 30 CFM.) (TO 28 INCHES)

GAST MANUFACTURING CORP., 139 Hinkley St., Benton Harbor, Mich.

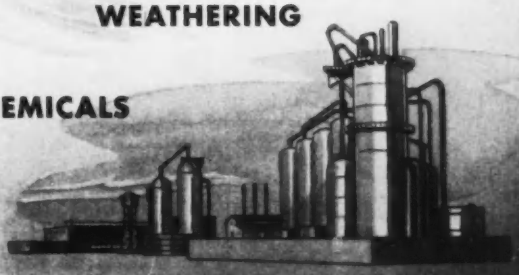
Rubber Parts to Resist . . .

TEMPERATURE

OILS and GAS

WEATHERING

CHEMICALS



ABRASION

STALWART-developed rubber compounds are available in mass produced parts to meet your applicational requirements. These parts retain their physical, chemical and dielectric properties regardless of the effects of extreme temperatures, oil and gasoline, chemical action, abrasion and weather.

STALWART rubber compounds are supplied in precision molded, extruded, die-cut and lathe-cut shapes for application in aircraft, automobiles, trucks, marine equipment, railroad rolling stock, processing equipment, electrical assemblies, and other equipment. In addition, these parts can have varying degrees of hardness, tensile strength, and elongation to meet individual, S.A.E. or A.S.T.M. specifications.

Write today for the new 16-page illustrated multicolored catalog Number 51SR-1 for additional details.

192-SR

STALWART RUBBER COMPANY

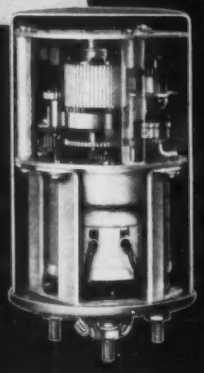
11166 Northfield Road • Bedford, Ohio

Designed to meet U. S. Government requirements

Cramer

HERMETICALLY SEALED **timing relays**

type HRR CIRCUIT RECLOSING RELAY



Compact . . . sturdily constructed . . . reliable in operation . . . the Cramer Type HRR Circuit Reclosing Relay is designed to perform many functions including: (1) Use as protective device for electronic equipment which automatically restores the equipment to service following a minor fault, yet protects the equipment against damage should the fault persist; (2) As a supervisory control for the automatic starting of engine, the Type HRR Relay applies specific cranking periods at spaced intervals and locks out the control should the engine fail to start within a prescribed time.

*

These instruments have been successfully tested under the following conditions:

Temperature: -65 + 185 F.

Acceleration: 75 G's

Vibration: 5 to 60 cps. at 1.32" amplitude

Salt Spray: 200 hours

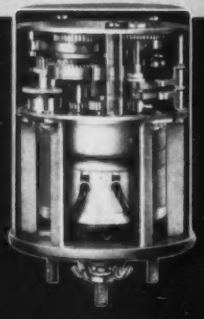
Inclination: Any position

Humidity: 100% plus condensation

Altitude: 50,000 ft.

Miscellaneous: Fungus, dust and sand

type HTI MINIATURE TIME DELAY RELAY



Constructed from standard Cramer time-tested components in a compact form, the Type HTI Miniature Time Delay Relay is primarily designed for use in electronic circuits . . . or in any application where it is desired to provide a fixed time delay between the closing of a control circuit and the subsequent closing or opening of a secondary circuit.

Type HTI Relays are available in maximum time ranges from 30 seconds to 30 minutes.

For complete information, write for Bulletin No. 4000A

THE R. W. CRAMER CO., INC.

BOX 7, CENTERBROOK, CONN.

Builders of dependable timing devices for more than 25 years.

INTERVAL TIMERS • TIME DELAY RELAYS • RESET TIMERS • CYCLE TIMERS
PULSE TIMERS • RUNNING TIME METERS • PERCENTAGE TIMERS

FCRST

spindle closes a switch which stops the timing mechanism and actuates the electrical indicator.

Another feature of the new device is the control unit which contains an alarm system designed to give both audible and visible indications when the fluid reaches its initial point of gelation. The meter automatically stops at this point, leaving the final reading, to the nearest tenth of a minute, on the meter's dial. The control unit also contains the timing circuit and power and test switches.

A small Calrod heating unit and a condensing coil are used to keep the boiling bath at a known constant temperature.

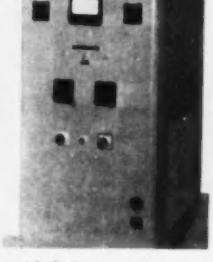
Mounted on a ring stand with a 7 x 10 in. base, the gel-time meter has an over-all height of approximately 20 inches and weighs 20 pounds. It operates on 115-volt, 60-cycle, 350-watt power.

General Electric Co., Schenectady 5, N. Y.

D-c Armature Winding-Insulation Tester

A new d-c winding-insulation tester for d-c armatures, series field coils, and low-impedance a-c stator coils will detect and aid in locating faults in turn-to-turn, coil-to-coil, and winding-to-ground insulation in d-c armatures of any size and rating. It is designed for testing large motors and generators such as those in railroad, marine, and steel industries.

The d-c armature winding-insulation tester consists of a repeating type, surge-voltage generator which operates 60-times a sec and a cathode-ray oscilloscope, all in one cabinet. A fixture



is provided for applying test voltage to the commutator of the armature being tested.

According to the manufacturers, the

new tester can check an entire armature in as little as three or four minutes. Insulation faults are indicated by a change in wave shape or amplitude or both proper shape and amplitude.

The heart of the new device, the surge generator, consists of 0.5 mf capacitor which is charged in one half cycle and discharged in the next half cycle. Voltage on this capacitor is adjustable in two percent steps up to a 7-500 v peak. The discharge takes place through a pair of ignitron rectifiers connected back to back. This system permits oscillatory output and complete discharge of the surge capacitor.

Once triggered by the surge, a standing wave is shown on the oscilloscope screen. Sensitivity is variable by voltage divider so that the surge-wave picture may be adjusted to any proportions for the full range of surge voltages.

The oscilloscope screen can be calibrated for the measurement of surge-crest voltages, allowing the surge voltage to be measured within approximately 3 percent accuracy on the screen. The oscilloscope tube is protected by a quarter-inch safety glass window which is hinged so that measurements may be made directly on the tube face.

The unit operates on 230 v, 60 cycles.

General Electric Co., Schenectady 5, N. Y.

Snap Action Switches for Automatic Equipment

These new Snap-Action switches employ the over-center coil spring construction which permits a wide range of actuating pressures by specifying a spring element of the proper characteristics for any job. The switches are mounted on Bakelite panels; bracket and actuator materials are brass; blades are phosphor bronze and contacts are of fine silver. The new 2,000 standard model has a release force of 5.5 oz and requires an operating force of 7.5 oz. The new 2001 standard model has a release force of 2.7 oz and requires an operating force of 4 oz. Both of these models are Underwriters' Laboratories inspected. They have UL ratings of 6 amps, 125 v a-c and 3 amps, 250 v a-c.

Special adaptations of these models are available offering variations in contact size and materials, spring pressures, actuator shapes, mounting holes and multiple mountings on a single panel. Actuators of the standard models are cam-following. These may be

Parker
makes all these

AN 6227 and AN 6230 Hydraulic - RINGS
5427 and 5430 High-Quality Industrial - RINGS
AF-934 Fuel Resistant - RINGS
AMS 7270 Fuel Service - RINGS
AMS 7274 Oil Service - RINGS
AN 6290 Fitting Gasket - RINGS
Special Service - RINGS

and ONLY Parker makes them ALL ...Every Parker O-Ring fully meets requirements of applicable specifications

...and ONLY Parker has:
- most complete mold-making facilities
- most thorough compound formulations
- most extensive research facilities
- strictest quality-control processes
- most exacting inspection and handling

Popularly used O-Rings stocked by authorized distributors in principal cities. Special Service O-Rings of tested and approved compounds supplied on order. Write now for new Parker Catalog No. 5100 which includes complete basic data on O-Ring sealing.

THE PARKER APPLIANCE COMPANY
17325 EUCLID AVENUE, CLEVELAND 12, OHIO
Plants in Cleveland — Los Angeles — Eaton, Ohio — Berea, Ky.

Parker
TUBE FITTINGS
VALVES - O-RINGS

The PARKER Appliance Company,
17325 Euclid Avenue
Cleveland 12, Ohio
Please send me my free copy of new O-Ring Catalog No. 5100.

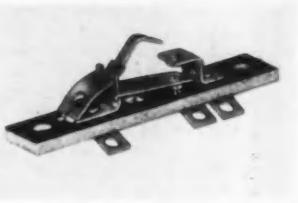
Name_____
Company_____
Address_____
City_____ State_____

Prior to the incorporation of circuit breakers in transformers, overloading and short circuiting of miniature electric train systems were the causes of many fires. This new Jefferson Toy Transformer provides complete protection for transformer, train and equipment. When all's well, the green light burns—but when an overload or short occurs, the red light flashes on and the entire circuit is broken before damage can be done. When the trouble is corrected, pressing the re-set button re-establishes the circuit.

The exaggerated perspective drawing shows the Chace Thermostatic Bimetal slotted into a "hairpin" element "A". It will carry the normal current without response but when an overload occurs, resistance to the increased current causes the bimetal to heat up; the high responsive side being down, the bimetal bends upward, opening the main contacts "B" and closing the red light contacts "C". The coil spring "D" locks the contact in an open position as the bimetal cools and resumes position. When the trouble is corrected, the re-set is pushed down, the red light circuit is broken and the coil spring "D" holds the main circuit contacts together for the continued operation.

Jefferson Electric fabricates this element from Chace #2600 strip. The 29 types are also available in random coils or in elements fabricated and assembled to customer specifications. Ask for our 64-page reference on thermostatic bimetal element design, then consult the Chace Applications Engineers before you proceed with development of your own temperature responsive device.

W. M. CHACE CO.
Thermostatic Bimetal
1607 BEARD AVE., DETROIT 9, MICH.



replaced with ratchet, plunger or other types of actuator controls. The snap-action switches may be used in products such as coin-operated vending machines, record changers, washing machines, and aviation, automotive, industrial and marine controls.

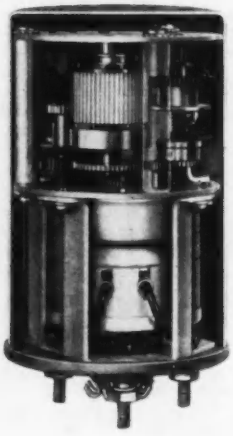
Cherry-Chanmer Corp., 1490 N. Skokie Blvd., Highland Park, Ill.

Reclosing Relay Automatically Tests Continuity

The Type HRR circuit reclosing relay is a protective device which automatically tests the continuity of a fault for a given number of times at specific spaced intervals. Should the fault be cleared during any one of the trial tests, the control is restored to its normal operating condition. However, should the fault persist, the protective device automatically locks out the control circuit until the fault has been cleared manually.

Versatile in operation, these relays, when combined with various types of sensing devices can test for the continuity of normal or abnormal conditions of voltage, frequency, current, pressures, speed, weight, light, and others.

Typical uses include: a protective



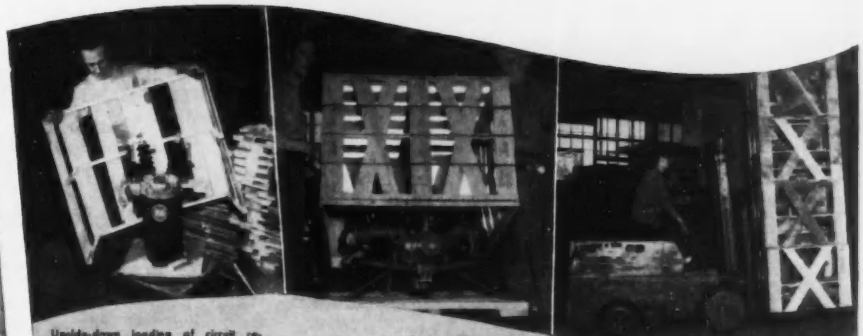
Now, more than ever before...

YOU NEED THE PROTECTION OF

WIREBOUND BOXES and CRATES

Losses due to container failure have no place in an industrial economy facing material allocations and shortages. That's why you should investigate *Wirebounds* —which combine the strength of steel with thinner wood to bring you *better product protection at lower cost.* Three hundred graduate engineers of the Wirebound Institute have been technically trained to design tailor-made *Wirebounds* which assure damage-free product delivery. The value of this container engineering is clearly demonstrated in the following case histories. We will be glad to show you how these benefits apply to *your* product. Use the coupon below.

YOU CAN CUT DAMAGE CLAIMS LIKE THIS:



Upside-down loading of circuit reclosers caused breakage, leakage, sometimes irreparable damage in handling and transit. Since switching to Wirebounds, company reports damage claims have become negligible.

Using Wirebounds designed to "float" 400 lb. precision engines, this manufacturer chalked up a record of 3000 shipments in fifteen months without a single instance of damage in transit due to container failure.

Flexible power saw maker reduced shipping weight from 820 to 775 pounds, cut crating time 30%. Company stacks and handles units four high. Shipping damage due to container failure has been completely eliminated.

choose your course of action...

Wirebound
BOXES & CRATES

☐ Send me general information . . . complete descriptive book titled "What to Expect from Wirebounds."

☐ Send me specific information . . . tear sheets of case histories of packing products similar to mine.

☐ Give me direct action send an Institute trained sales engineer to show the advantages of Wirebound packing for my own product.

NAME POSITION

FIRM

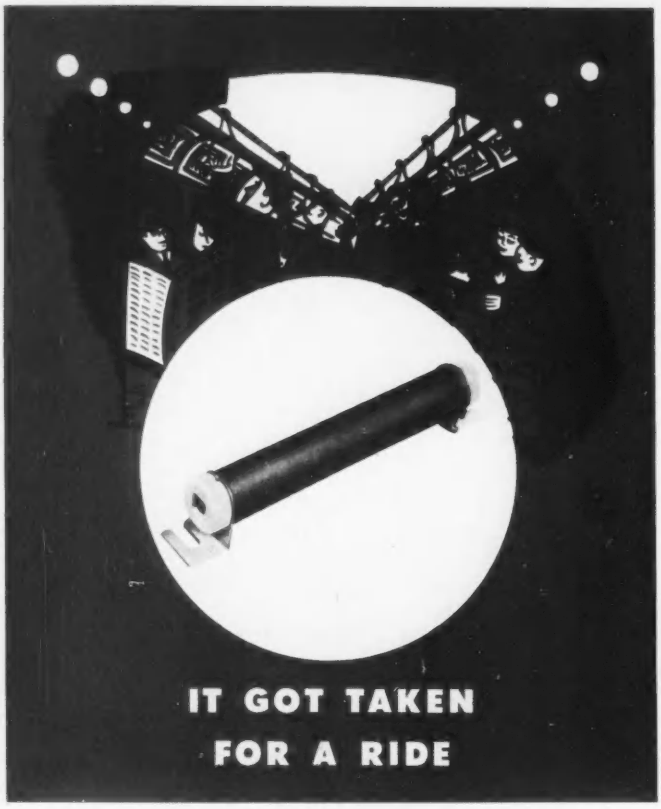
STREET AND NUMBER

CITY ZONE STATE

OUR PRODUCT IS IT WEIGHS

Users names on request

mail now to WIREBOUND BOX MANUFACTURERS ASSOC.
Room 1152—327 South LaSalle Street, Chicago 4, Illinois



and liked it!

This Ward Leonard Vitrohm bracket terminal resistor was installed in the fluorescent lighting system of the new subway cars for three important reasons.

First, it could withstand the wear and tear of constant vibration and shock of starts and stops.

Secondly, it could be installed faster and easier in very limited space.

In the third place, although these resistors last indefinitely, they must be readily replaceable in case of accidental damage.

These subway cars run on 600 volt D. C. The builder provided pre-wired terminal studs. By using a bracket terminal resistor it was possible to combine mounting and electrical connection in one simple, fast installation.

That's Ward Leonard "result-engineering"—problems turned into perfect performance by the proper selection or adaption of electric controls. Write for Vitrohm Resistor Catalog, Ward Leonard Electric Co., 63 South Street, Mount Vernon, N. Y. Offices in principal cities of U. S. and Canada.

WARD LEONARD
ELECTRIC COMPANY
Result-Engineered Controls Since 1892
RESISTORS • RHEOSTATS • RELAYS • CONTROL DEVICES

W L

device used in conjunction with an overload relay for radio and radar transmitters; a time limit device used in conjunction with a voltage relay or centrifugal switch for the automatic starting of engine generators; as a protective device used in conjunction with an overload relay for transmission or communication lines.

The R. W. Cramer Co., Inc., Centerbrook, Conn.

Pressure Sensitive Writing Tape

A new pressure sensitive tape requires no moistening, will adhere to metal, wood, glass, plastics and any clean surface. It may be transferred from one surface to another without destroying its adhesive qualities.

Made of two layers of acetate with a white waxy substance sandwiched in between, it is the pressure of the writing instrument rather than the lead that makes the impression on the tape. It cannot be erased, smudged, or rubbed out, and in addition is water proof, oil proof, tamper proof, and acid resistant.

Available in black, blue, red, or green in 8 mm, $\frac{1}{2}$ in., $\frac{3}{4}$ in., 1 in., $1\frac{1}{2}$ in. widths, in 400 in. and 800 in. rolls. Tape will adhere and retain legibility from —40F to 160F.

Labelon Tape Co., 100 Anderson Ave., Rochester 7, N. Y.

Low Pressure Relief Valve Has Accurate Control

A new type A-120 relief valve is now used that features positive, control on 2 p.s.i. air pressure and large volume exhaust at 3 p.s.i. Originally developed for use on inflatable rubber boats, the new low-pressure valve has been engineered for uses involving fine control operation. The unit withstands government salt spray tests as well as aging and dirt accumulation tests. In addition, A-120 has check valve characteristics because it permits only a one-way flow.

Recommended for applications in which accurate pressure control of air or gases is vital, A-120 valve is only $1\frac{1}{8}$ in. high and $7\text{-}\frac{3}{8}$ in. in over-all diameter. The working parts are mounted in a flexible rubber base and are fully protected by a steel cap and rubber shield. Components are fabricated from stainless steel and natural or solvent-resistant neoprene rubber stocks.

This new relief valve can be attached to either flexible or rigid surfaces. At-

tachment to flexible surfaces is accomplished by cementing valve base to the unit it will control. For mechanical mounting, the valve is supplied with bolt holes in the base to customers' specifications.

One of a line of special purpose valves, type A-120 has been developed for a compact, precision, low-pressure relief valve.

Andrews-Alderfer Processing Co., Inc., 129-1 Ash St., Akron 8, Ohio

Oiled Air For Pneumatic Tools

A new size lubricator with ½ pint oil capacity, for lubricating pneumatic tools, when placed in the air line, supplies a flow of "oiled air" to the working parts of the tool. An adjustable feeder enables the operator to adjust the oil flow to the needs of the job. Oil may be added under line pressure, and a pressure-proof window enables the operator to tell at all times exactly how much oil is in the lubricator.

Because it is made of a light-weight alloy, the lubricator causes no perceptible drag on the air line and its shape allows it to be pulled around corners without catching. The manufacturer reports that the lubricators have been used in mines, quarries, aircraft plants, shipyards and on construction jobs.

The new model is 7 in. long, 3½ in. in width and height, and weighs 32 oz. Other sizes of lubricators range from 4½ in. to 10 in. in overall length and from ⅛ to a full pint in capacity.

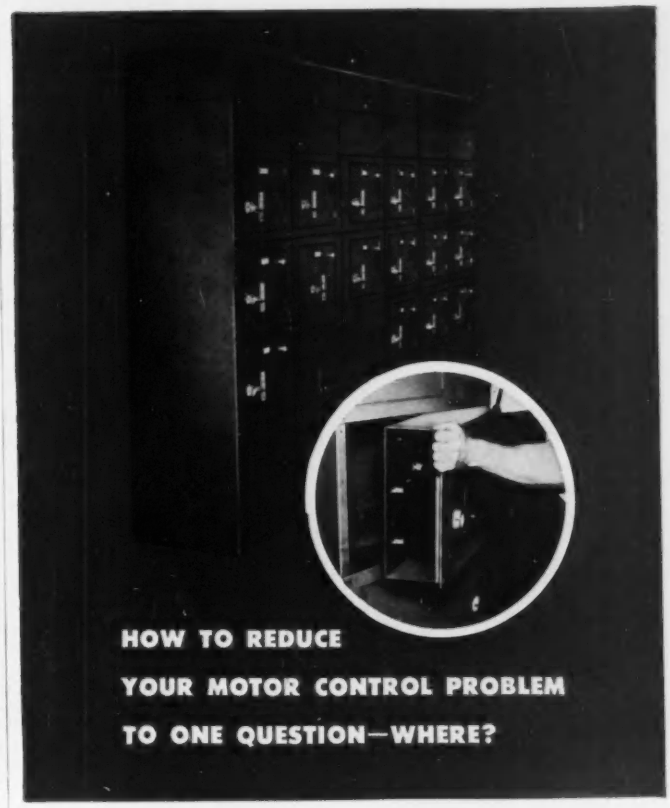
The Rucker Co., 4228 Hollis St., Oakland, Calif.

Bolt Fastener Is Self Locking

Installation of a new self locking sleeve bolt fastener is a one man operation. The sleeve is first inserted into the hole to the depth required. The bolt is then driven thru the sleeve spreading the 6 prongs formed by the slots at the end of the sleeve. The expanded prongs are thus imbedded into the material or flared on the outside of the hole and hold the sleeve fastener in place. The bolt head is said to automatically countersink itself into a wood surface.

This fastener is made in sizes from ¼ in. to 1 in. diameter; lengths from 1 in. up, and with hex, square, round, flat or slotted heads.

Square Tool & Die Co., 1550 N. Freemont St., Chicago 22, Ill.



"Building-block" units permit grouping all motor controls at one point

You control *all* the motors in an entire area, floor or building—when you *centralize* the controls with Ward Leonard MULTITROL*.

Prefabricated MULTITROL units (each a complete control for one motor) fit into standard framework in any arrangement to suit the space. Units can be added, subtracted, interchanged, or relocated.

Some of the problems MULTITROL solves include: *Structural framework*—none needed, MULTITROL units are free-standing. *Obstructions*—no difficult cable or pipe forming, no chopping out walls. *Appearance*—no haphazard box mounting. *Safety*—completely deadfront construction.

Investigate MULTITROL. Wide choice of starter types, combined with externally-operated thermal circuit breakers. Write for Bulletin 4410. WARD LEONARD ELECTRIC CO., 63 South Street, Mount Vernon, N.Y. Offices in principal cities of U. S. and Canada.

*Also available for D-C

WARD LEONARD ELECTRIC COMPANY

Result-Engineered Controls Since 1892

RESISTORS • RHEOSTATS • RELAYS • CONTROL DEVICES

BETTER PRESSURE CONTROL

for high pressure oil-hydraulic systems

DENISON HydrOILics

Relief, Sequence and Unloading Valves for circuits up to 5000 psi

You get *faster action* with Denison Pressure Control Valves because their balanced design *reduces the differential between opening and closing pressures.* Complete hydraulic balance permits closer pressure control and reduces over-pressure and pressure-drop conditions. Extremely close fit of all inner sealing surfaces also increases efficiency in these valves. Leakage approaches *zero.*

The rugged, compact construction of Denison HydrOILic Valves saves space and simplifies circuit design. Available either with threaded bodies or for subplate mounting, they offer widest latitude for positioning in the hydraulic system. Control caps can be rotated to place adjustment knobs in most convenient position. Remote control is easily provided for the pressure unloading adjustment.

These and other Denison features are the result of more than a quarter-century of experience by *specialists* in oil-hydraulic equipment. Users in every field report that Denison HydrOILic Valves quickly prove their advantages in actual circuit performance. Write for full details.

The DENISON Engineering Co., 1157 Dublin Rd., Columbus 16, Ohio

DENISON
PRESSURE CONTROLS

Sans, Souci

Ad Libbing By The Editor

With all due apologies to the cartoon, "Born thirty years too late", I sure got a kick out of it when I read Herbert Hoover's announcements concerning national honesty and integrity. And I blandly confess that Mr. Hoover presented the situation in a far superior and more comprehensive manner than I did in the October edito-ial.

In his presentation, Herbert Hoover took to task the average individual. He blamed the individual citizens for tolerating the existing conditions of immorality and lack of integrity. Every honest person must agree with him.

It is surprising how men of presumable intelligence and high standing will permit degrading of their own moral standards. I was aghast one time when I was discussing with a highly reputable business man the fate that had befallen a national figure who had been kicked out of office because of his highly unethical operations. My friend remarked, "You seem to condemn him rather harshly. Did you ever meet him at a cocktail party?" My heart sank. Here this man, a well known national figure, was virtually condoning immorality because the individual concerned was a boon companion at a cocktail party.

Too many men excuse dishonesty in government on the basis that you find dishonesty in business. They fail to recognize that the prevalence of an evil does not mitigate the evil. It simply reflects the degradation of moral standards.

Well so much for that. I was getting a report on Washington doings. The report concerned the engineering design of our latest military aircraft. The reporter pointed out that the cost of electronic equipment in jet fighters is more than the total cost of a World War II Mustang. I believe that is true or very nearly so. In any event, the implications go way beyond the dollar sign. It simply means that all of that additional equipment must be serviced and kept operative. It means far greater complications and more men required to maintain the equipment. This brings up the question as to whether we will eventually arrive at a point where the military equipment is so complicated that the manpower required to keep it in operation will be all out of proportion. Is it not possible that we might eventually reach a point wherein the manpower required for maintenance becomes pro-

hibitive? Of course the glib answer is to design the equipment so that it will require far less maintenance. In other words, just pass the buck back to the engineers who designed it.

Not long ago I heard a man talking about the fruits of frustration. The point he was trying to make was that every problem we encounter and lick gives us just that much more ability and character. And furthermore, at the worst the man of great strength of character will always find some way of using his worst calamities as the basis for a subsequent accomplishment. In other words, a man of strength and character does not bow down and give up when facing conditions that to many others would be intolerable. The man who developed the Saranac Lake Sanitarium was a doctor who had been stricken with consumption, had gone to the lake hoping to find a cure and by his determination and confidence found it. He then dedicated his life to making that cure available to all fellow sufferers.

Today many of our young men starting their business career are completely frustrated. Only to frequently the men that I interview for a job first ask, "What security do you offer?"

When a man looking for a job is primarily interested in security, it simply indicates that his views have been warped by circumstances or otherwise. What he should be interested in is the opportunity offered by the job. If the man is given full opportunity for advancement, if the career on which he is embarking is one which offers good chances for advancement in position, and increases in the pay envelope, the question of security will take care of itself. The man whose foremost thought is security is living in the present and has done little thinking about the future.

If the job offers good opportunities; if the work is of a broadening nature and conducive to development, and if the immediate compensation is favorable, that is all that the job applicant need worry about. He himself can then take care of his security, and he is the only one that can do it.

Of course this does not mean that a man should not speak up for himself. One of the troubles of the engineering profession is that the engineers have not done enough talking in the sense of public relations. The story of the mousetrap built in the woods is only a myth. If the public is not made aware of the place of engineering in our civilization it is not the public's fault that they are not cognizant of the part played by engineering in furnishing the innumerable material benefits, comforts and luxuries which we enjoy.

SHOCK TROUBLES ENDED

in oil-hydraulic circuits of 5000 psi

DENISON HydrOILics

Surge Damping Valves

PREVENT destructive pressure shock

The harsh vibrations and shock impulses set up in hydraulic circuits by sudden starts, reversals,or pressure surges in the oil flow, are *prevented at their source* (not merely absorbed) by the Denison Surge-Damping Valve.

These small, compact valves are rugged, self-contained units, designed with no moving oil seals. They require no maintenance or adjustments. Easily installed in any hydraulic circuit, they adjust automatically to any working pressure up to 5000 psi, and do not interfere with any of the circuit's regular functions.

Denison Surge-Damping Valves are available in both *industrial* and *aircraft* models. Two industrial sizes, with either ½" or 1" internal pipe threads on each end, are recommended for circuit pressures to 5000 psi. The smaller aircraft model, with external tube thread connections, is made in four sizes—¼", ⅜", ½" and ⅝"—and is recommended for systems to 3000 psi.

Write today for complete information on Denison Surge-Damping Valves.

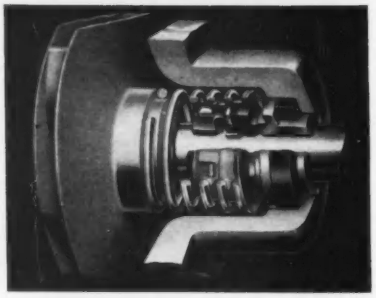
The DENISON Engineering Co., 1157 Dublin Rd., Columbus 16, Ohio

DENISON
SURGE DAMPING CONTROLS

There's a JOHN CRANE Mechanical Seal To Meet Your Exacting Requirements

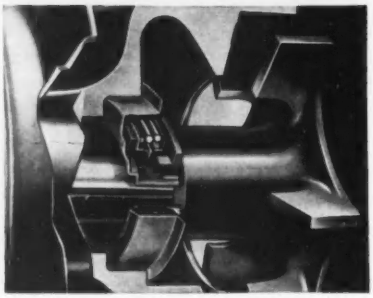
General Purpose Seal . . .

. . . most widely used end-face seal in industry . . . ideal for centrifugal, rotary and jet pumps, gear reducers and many other rotary shaft applications . . . offers long life, complete flexibility, easy installation. Two types available, No. 1 and 2, for varying equipment space conditions.



Low Cost, High Quality "Pressed-in" Seal . . .

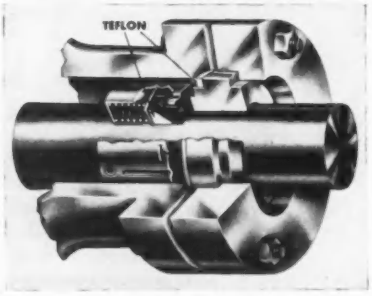
. . . the answer to small shaft sealing applications involving high speeds and vibration. Millions of these Type 6A Seals are mass-produced for automotive water pumps, making them available at a relatively low cost in stock sizes. Each of these easy-to-install seals will fit several shaft sizes since they are "pressed-in" and do not touch the shaft.



High Temperature Anti-Corrosive Seal . . .

. . . This Type 9 Seal performs effectively at temperatures up to 485° F. It incorporates a *Teflon* flexible member which is unaffected by all known corrosive agents.

★ ★ ★



All seals in the "John Crane" line are end-face in design . . . nothing touches the shaft which can score it. No matter what your mechanical sealing problem is, there's a "John Crane" seal designed to exactly "fill the bill". Our trained field engineers are ready to work with you in selecting the best seal for your needs.

Write for entirely new catalog on "John Crane" Mechanical Seals. It's just off the press!

Dept. PE-11, 1845 Cuyler Avenue, Chicago 13, Illinois.

JOHN CRANE
PACKINGS AND MECHANICAL SEALS
CRANE PACKING COMPANY
CHICAGO
Offices in All Principal Cities in United States and Canada

MEETINGS

November 1-2

SOCIETY FOR THE ADVANCEMENT OF MANAGEMENT—Annual Conference, Hotel Statler, New York, N. Y.

November 5-7

NATIONAL ACADEMY OF SCIENCES—Autumn Meeting, Yale University, New Haven, Conn.

November 5-8

AMERICAN PETROLEUM INSTITUTE—31st Annual Meeting, Stevens Hotel and Palmer House, Chicago, Ill.

November 7-9

AMERICAN SOCIETY OF BODY ENGINEERS—Sixth Annual Technical Convention, Rackham Memorial Building, Detroit, Mich.

November 8-9

AMERICAN MANAGEMENT ASSOCIATION—Production Division Conference, Palmer House, Chicago, Ill.

November 8-9

NATIONAL CONFERENCE ON INDUSTRIAL HYDRAULICS—Seventh Annual Conference, Sherman Hotel, Chicago, Ill.

November 19-20

NATIONAL METAL TRADES ASSOCIATION—52nd Annual Convention, Palmer House, Chicago, Ill.

November 25-30

AMERICAN SOCIETY OF MECHANICAL ENGINEERS—Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

November 26-December 1

CHEMICAL EXPOSITION—23rd Exposition of Chemical Industries, Grand Central Palace, New York, N. Y.

November 28-30

SOCIETY FOR EXPERIMENTAL STRESS ANALYSIS—Annual Meeting and Exhibition, Bellevue-Stratford Hotel, Philadelphia, Penna.

November 28-30

SCIENTIFIC APPARATUS MAKERS ASSOCIATION—Midyear Meeting, Laboratory Apparatus: Optical, Nautical, Aeronautical, and Military Instrument Sections, Hotel New Yorker, New York City.

December 4-5

TRANSPORT AIRCRAFT—Hydraulic Accessory and System Conference, Hotel Sheraton, Detroit, Mich.

PRECISION,

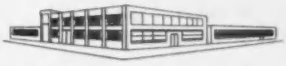
PLUS

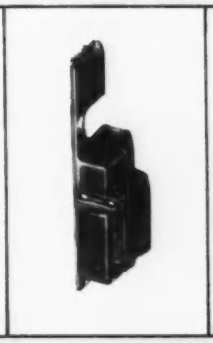
Precision in die castings is easily measured. Not so easy to calculate is the *extra* care that goes into castings produced by ADVANCE PRESSURE CASTINGS.

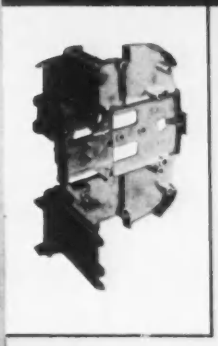
From blueprint stage on, expert engineers, skilled metallurgists and careful craftsmen take full advantage of their know-how, our custom tooling and complete-under-one-roof production facilities to give you a product superior in every respect.

By being far more demanding than our customers, we have been able to maintain the quality that has built a small shop into one of the largest and best equipped plants in the East.

We will gladly discuss any casting problem you may have, without obligation.







SALES OFFICES:

718 Ellicott Square Building
Buffalo 3, New York

15324 Mack Avenue
Detroit 24, Michigan

2406 South Seventh Blvd.
St. Louis 4, Missouri

215 Sixth Street S. E.
Minneapolis 14, Minnesota

ADVANCE PRESSURE CASTINGS Incorporated

46 N. 15th St., Brooklyn 11, N. Y.

THINKING OF STAINLESS...
THINK OF
ALLMETAL
FOR THE FINEST IN
STAINLESS STEEL FASTENERS
FOR QUALITY AND DELIVERY
Complete facilities under one roof assures controlled quality and immediate delivery. Standard and "AN" specs. Specials to order.
ALLMETAL, Specialists in Stainless, Produce Stainless Products Exclusively
Write for Catalog F
MANUFACTURERS SINCE 1929
ALLMETAL
SCREW PRODUCTS COMPANY, INC.
33 GREENE STREET NEW YORK 13, N. Y.

4 STAR TIMER
★ No false contacts
★ No chatter
★ Quiet in operation
★ Eliminates double contacting or breaking of circuit
HYDROGEN PACKED
Durakool
STEEL MERCURY TIMERS
The steel-clad "fixed time" Durakool timer-relay operates in "sealed in" hydrogen under pressure, with mercury to mercury contacts. Timing is tamperproof. Non-breakable and built for millions of contacts. Fixed time delays available from 1/6 to 20 seconds, either normally open or normally closed action.
See Telephone Directory for Local Distributor or write
Durakool, Inc. Elkhart, Indiana
Send for Bulletin 800

ENGINEERING ABSTRACTS

Reducing Residual Stresses

Foreign abstract of "Mechanical Methods of Reducing Residual Stress" from The Engineer, June 29, 1951.

RESIDUAL STRESS REDUCTION in cold drawn materials by annealing often involves temperatures at which there is some risk of deteriorating surface quality or reducing tensile properties. A redistribution of stress with a lowering of peak values may be obtained by mechanical means.

The type, amount and distribution of residual stress in a cold-drawn bar are dependent on the reduction of area undergone. With considerable reduction there is compression at the centre of the bar and tension at the surface, whereas if the amount of reduction is small the surface is in compression and there is tension at the center (Fig. 1). In a 50 mm diameter bar, the reversal of sign occurs at about 0.8 percent reduction of area in 33 ton steel and at about 0.5 percent reduction of area in a lead-bearing 60:40 brass. From this behavior it may be expected that the original tensile stress at the skin of a cold-drawn steel bar would be lowered by the superposition

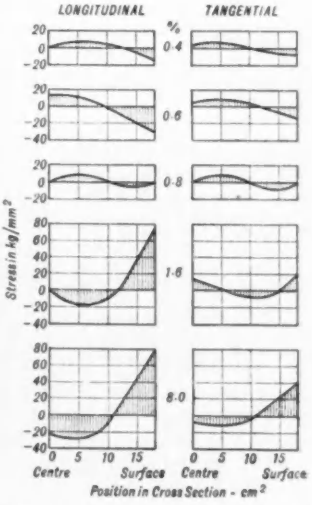


FIG. 1—Influence of the amount of cold drawing (0.4 to 8.0 percent reduction of area) on the distribution of residual stress in a cold-drawn 50 mm diameter bar of a thirty-three ton steel.

of a compression stress induced by a small reduction of diameter in a subsequent cold-working operation. In factory test the bars went through an additional drawing operation; in the laboratory short lengths were pressed through a die. The effect is shown in Fig. 2. The maximum residual longitudinal tensile stress of 34 tons per sq inch in the bar cold drawn from 50 mm to 48 mm diameter was re-

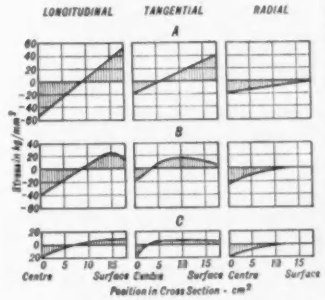


FIG. 2—Residual stress in a steel bar (carbon 0.19, manganese 0.93, copper 0.68 and chromium 0.43 percent) cold drawn from 50 mm to 48 mm diameter (A), and the effect of pressing through a die to (B) 47.8 mm and (C) 47.75 mm diameter. Final residual stress is 7.5 tsi.

duced to 10 or 12 tons per sq inch by a second drawing to 48.8 mm diameter, and to 7.5 tons per sq inch by a further drawing to 47.75 mm diameter. The amount of reduction in the second cold-drawing operation is somewhat critical, and must be carefully controlled. A reduction in diameter of the original cold-drawn bar from 48 mm to 47.7 mm, though causing a redistribution of the stresses, was less effective in eliminating longitudinal tensile stress (Fig. 3). The two stages of cold drawing can be combined into one operation, and the bar drawn through two dies arranged in series with a sufficient distance between them for the bar to be lubricated before it enters the second drawing stage. In a 0.18 percent carbon steel, cold drawn from 50 mm to 48 mm diameter, the residual surface tensile stresses were 27 tons per sq. in. longitudinal and

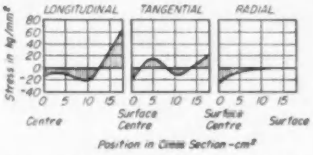
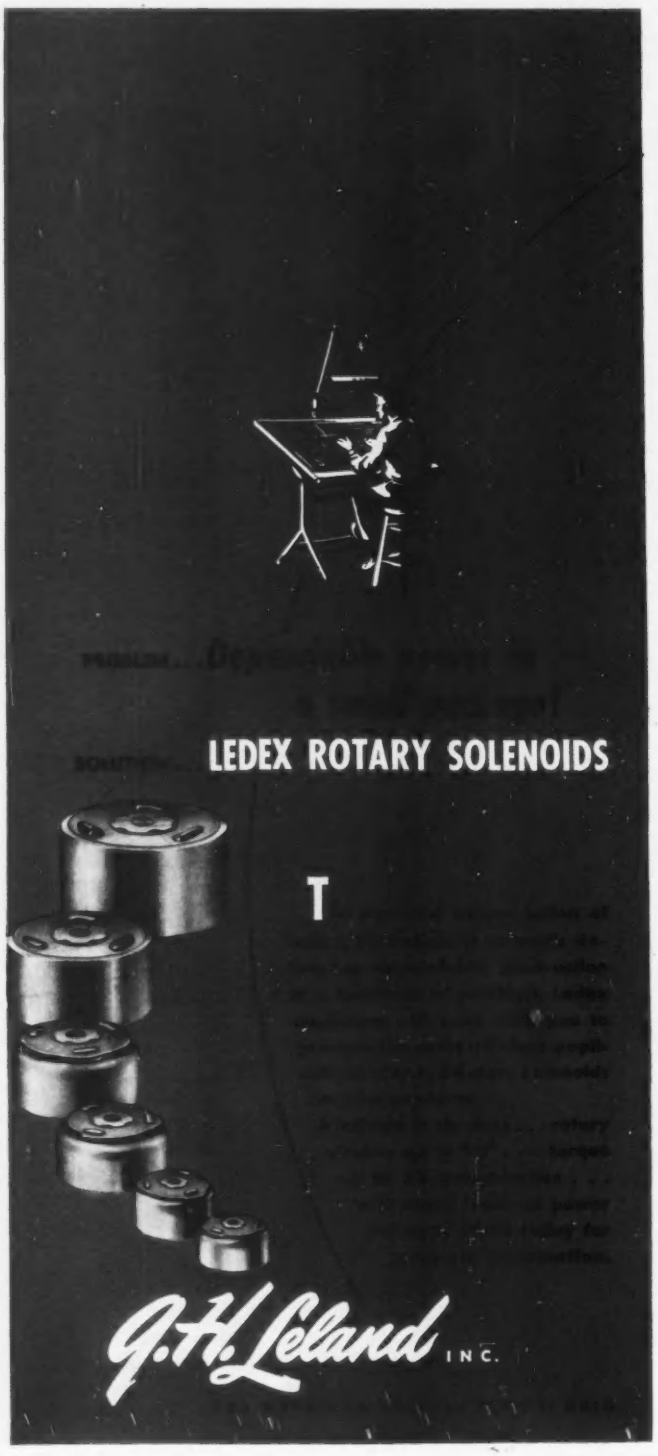


FIG. 3—Effect on the internal stress distribution shown in Fig. 2 (A) of pressing a 50 mm bar through a die to 47.7 mm diameter; reduction area 1.2 percent.

where HARD RUBBER is right... use it!
EVERY GLASS OF WATER
gives it a whirl
● The little water meter in your cellar puts hard rubber to the most exacting test a material can get. The disc piston, for example: It spends 10 – even 20 – years under water, and oscillates through a dozen cycles for every glass of water. Machined as precise as 0.0005", it must neither warp, swell, nor wear, or the meter's accuracy would be lost.
Some discs are blanked from Ace Hard Rubber sheet; others start as moldings with metal cores. Moisture absorption is as low as 0.04%, tensile strength as high as 10,000 psi. Special high-temperature compounds safely handle hot water.
There are Ace Hard Rubber compounds that are ideal for many of your mechanical and electrical parts too. Always consult your Ace Handbook when selecting materials – rubber or plastics – for today's production and tomorrow's plans.
80-page Ace Handbook Free to Design Engineers
HINTS FOR PRODUCTION-MINDED ENGINEERS
Meter bearings cut from tubes
Disc molded over metal core
Bearing plate punched from sheet
Meter turbine wheel, molded and machined
100th ANNIVERSARY
American Hard Rubber Company
93 WORTH STREET • NEW YORK 13, N. Y.



20 tons per sq. in. tangential. In the second stage the bar was reduced to 47.9 mm diameter and the stresses to 4½ and 5 tons per sq. in. respectively A bar subjected to the combined operation showed a final longitudinal surface stress of less than 4 tons per sq. inch.

A beneficial stress-relieving effect is attained not only by drawing through a die, but by any form of cold work which will impart a small amount of permanent deformation to the surface layers of the steel. Cold work which only deforms a thin surface layer, e.g., surface rolling, press polishing, reeling, sizing, etc., has a much smaller stress-reducing effect than the proposed drawing through a die (Fig. 4).

The principle of eliminating residual internal stress in steel bar by me-

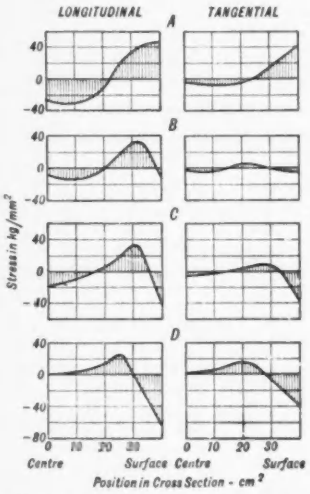
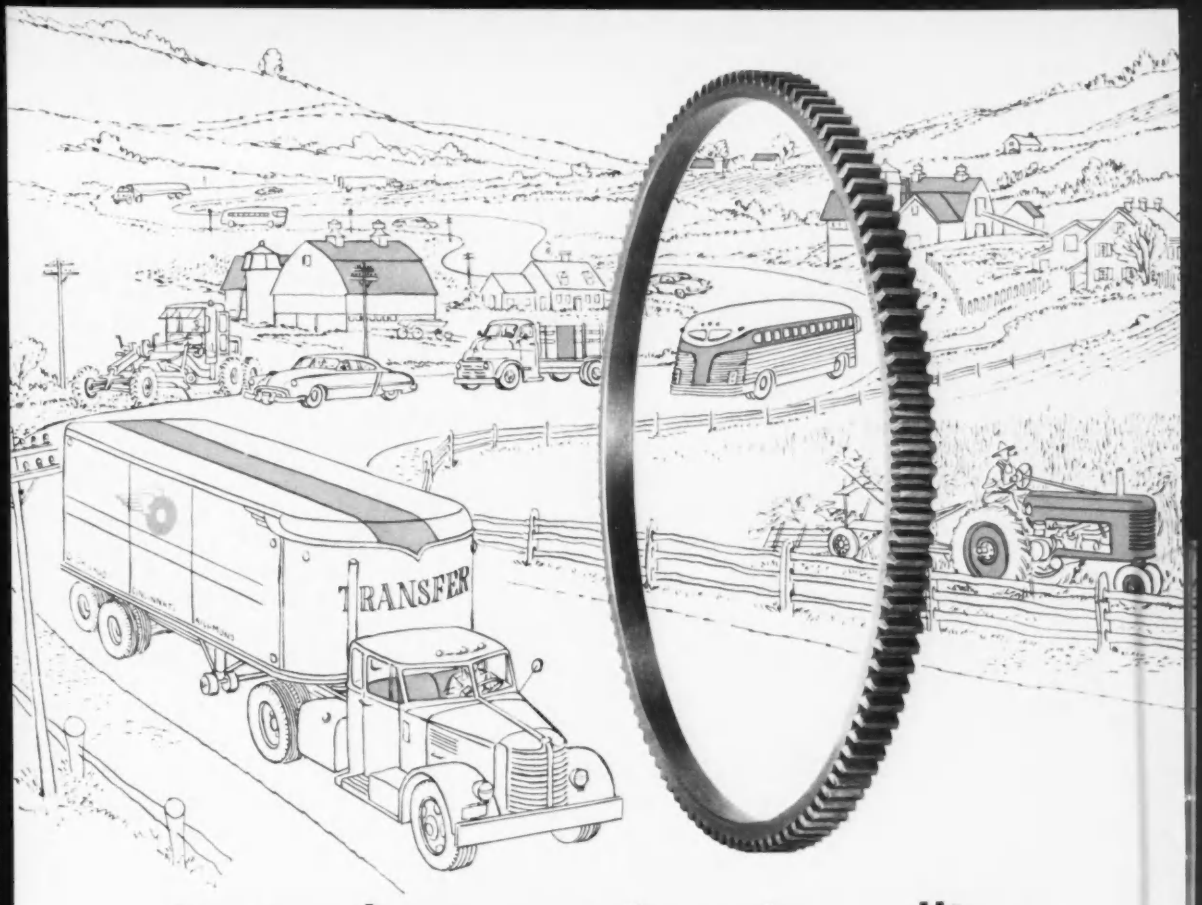


FIG. 4—Residual stress in a 27 ton (minimum), 0.19 percent carbon steel bar cold drawn from 72 mm to 70 mm diameter and ground to 69 mm diameter (A); then given a further reduction in diameter of 0.01 mm (B), 0.02 mm (C), and 0.026 mm (D) by press polishing.

chanical means offers economic advantages over heat-treatment methods. It is estimated that, taking the cost of simply drawing as 100, the cost of production including heat-treatment is 290, the cost including intermediate heat-treatments (which, in any case, are not effective in finally eliminating residual stress) is 370, while the cost including the second drawing operation is 122.

Mechanical methods of reducing residual internal stress on the grounds of economy, preservation or improvement of surface finish and maintenance of the mechanical properties of the



Gears that start America rolling

The millions of motors that keep America rolling on farms and highways are silent and powerless until flywheel ring gears help turn them into action.

Building flywheel ring gears that dependably *start* a multitude of engines is a part of our gear-making responsibilities. In vehicles of practically every type—trucks, buses, passenger cars, road machinery, farm equipment, whether gasoline or Diesel powered—"Double Diamond" flywheel ring gears help *start* the wheels that keep America rolling.

IMPORTANT NOTICE TO PRESENT AND FUTURE CUSTOMERS

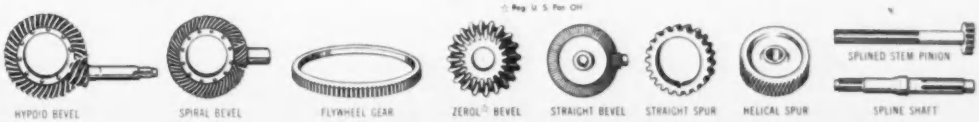
During the present abnormal period Automotive Gear Works believes its first loyalties are due its present customers, many of whom are directly or indirectly in defense work. For that reason, every effort will be made to first satisfy the growing requirements of those companies who are already users of "Double Diamond" Gears. Where facilities or materials permit, the requirements of prospective customers will receive careful attention, and technical assistance will continue to be made available for the solution of gear problems regardless of whether or not we are now in a position to build the gears recommended.

DOUBLE DIAMOND TRADE MARK GEARS

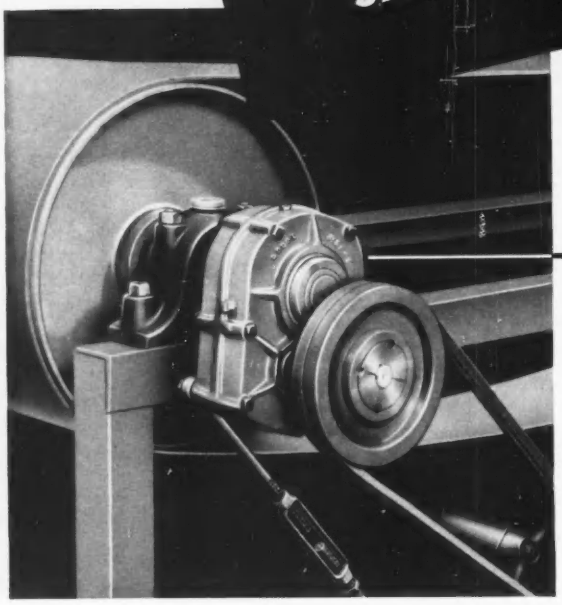
AUTOMOTIVE GEAR WORKS

RICHMOND, INDIANA

FOR AUTOMOTIVE, FARM EQUIPMENT AND GENERAL INDUSTRIAL APPLICATIONS



THE SPEED REDUCER THAT SAVES YOU MONEY!



Dodge

Torque-Arm

America's Most Complete Line of Shaft-Mounted Speed Reducers

- No special engineering required. No foundation to provide. No flexible couplings. No sliding base. No "lining-up" difficulties. No expensive installation. Stock TAPER-LOCK sheaves prescribed for each job to provide desired speeds. Application to other machines is practical and easy.
- Unit is driven through any V-Belt Drive. Torque-arm, fastened to any fixed object, anchors the reducer unit. Turnbuckle provides fast and accurate adjustment of belt tension.
- Backstop available from stock when required. Simple. Positive. Easily installed. Sealed inside the reducer housing.
- Compact, light weight, *rugged*. Quality built by Dodge for Dodge *dependable* service.
- Built in two series—Single and Double Reduction. Capacities from 1 to 27 h. p. Speeds from 12 to 330 rpm. Available from distributors' stocks.
- WRITE for special bulletin A602.

DODGE MANUFACTURING CORPORATION, 1200 Union Street, Mishawaka, Indiana

DODGE

of Mishawaka, Ind.

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable assistance on new cost-saving methods. Look for his name under "Power Transmission Equipment" in classified phone book.

FIRST IN POWER TRANSMISSION MACHINERY!

V-BELTS AND TAPER-LOCK SHEAVES

DODGE TIMKEN PILLOW BLOCKS

ROLLING GRIP AND DIAMOND D CLUTCHES

SOLID STEEL CONVEYOR PULLEYS

NAME PLATES

FOR YOUR NAME PLATE REQUIREMENTS, WRITE OUR SUBSIDIARY, CHICAGO THRIFT-ETCHING CORPORATION, 1555 SHEFFIELD AVENUE, CHICAGO 22, ILLINOIS

steel apply only to the tensile and fatigue properties. If restoration of the yield strength in compression is an essential requirement there would appear to be no alternative to the method of heat-treatment at a temperature of about 450 deg Centigrade.

Highly Sensitive Pneumatic Comparator

Abstract of "A Pneumatic Comparator of High Sensitivity" from The Engineer, July 13, 1951.

A COMPARATOR having very high sensitivity and good speed of response has been devised in a compact form. The principle is shown schematically in Fig. 1. Air from a constant pressure source is supplied first to an orifice O_1 and thence to an orifice O_2 through which it escapes to the atmosphere. For a given value of P, the magnitude of p depends on the relative sizes of O_1 and O_2. The relationship between p/P and M/C is given by a characteristic curve of the form shown in Fig. 1. This particular curve was obtained experimentally using an orifice O_1 of

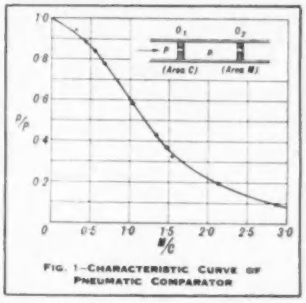


FIG. 1—CHARACTERISTIC CURVE OF PNEUMATIC COMPARATOR

fixed diameter equal to 0.033 in. and a constant value of P equal to 15 lb per square inch. It agrees quite closely with the equation

$$\left(\frac{M^2}{C}\right) = \frac{P}{p} - \frac{p}{P}$$

For values of p/P between 0.4 and 0.9 the curve differs little from the straight line equation

$$\frac{p}{P} = 1.10 - 0.50\,\frac{M}{C} \quad \ldots\ldots (1)$$

Within these limits, and for constant values of P and C, p may be regarded as a linear function of M. If the effective area of escapement of O_2 is arranged to depend on a dimentional quantity A in such a manner that alteration of A produces a proportional alteration of M, then changes in A may be determined by measuring the corresponding changes in p.

It is necessary that P should be kept constant in order to maintain a satis-

when line "feathers" make
the feathers fly...
... Switch to Arkwright Tracing Cloth! You can re-ink clean, sharp lines over any erasure without "feathering" or "blobbing" to spoil your work.
Painstaking Arkwright inspection guards your drawings against pinholes, thick threads or other imperfections—Arkwright quality insures them against brittleness, opaqueness, or paper-fraying due to age. That is why Arkwright Tracing Cloth takes clean, sharp drawings that yield clear, sharp blueprints years after you make them.
Remember: if your work is worth saving, put it on Arkwright Tracing Cloth. Would you like a sample? Write Arkwright Finishing Co., Industrial Trust Bldg., Providence, R. I.
ARKWRIGHT
Tracing Cloths
AMERICA'S STANDARD FOR OVER 25 YEARS
Arkwright
PENCIL CLOTH WHITE
Arkwright
TRACING CLOTH
Matsu
PENCIL TRACING CLOTH

Should you put *your* horsepower to work through some type of *friction clutch*—or some type of *hydraulic drive?* Or a *combination* of both.

Which will make your equipment operate *most efficiently,* at *less cost?* That's one of the tough problems operating men and design men must face today.

And there is only one sure way to find the right answer.

That's to work with application engineers like those you find at the Twin Disc Clutch Company. Men who are trained in applying *all* types of friction clutches and *all* types of industrial fluid drives. Men who are trained to give you an *impartial* recommendation . . . because no matter what the honest answer may be they can supply the type of connecting link *you should have.*

Yes, for the answer to *your* "which," consult the men who base their answers on the most complete line of industrial clutches and hydraulic drives . . . and on the extensive experience of *specialization* for over 30 years.

TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES

Clutches & Hydraulic Drives

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois

BRANCHES: CLEVELAND • DALLAS • DETROIT • LOS ANGELES • NEWARK • NEW ORLEANS • SEATTLE • TULSA

factory consistency of calibration.

The speed of response of the instrument will depend on several factors, the chief of which are (1) the value of P, (2) the area C of the first orifice, and (3) the volume V between the two orifices; the response improves when P or C is increased or V diminished. It has been seen that for high sensitivity C should be kept small, so that, in the determination of the optimum size of O_1, high sensitivity and quick response are conflicting demands. With C determined by the sensitivity requirement, improved response must be sought by reducing V to a minimum and making P as large as is conveniently practicable.

Description of Instrument

The instrument (Fig. 2) consists essentially of a hollow double piston which is an airtight sliding fit inside

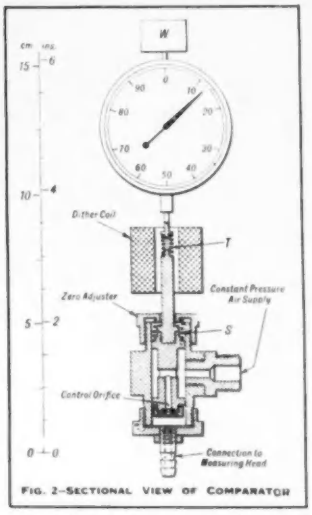


FIG. 2—SECTIONAL VIEW OF COMPARATOR

a cylinder of $\frac{1}{2}$ in. bore, the radial clearance being only about 0.0001 in. Compressed air, maintained at constant pressure by a precision pressure regulator, is supplied to the center of the cylinder, whence it flows downwards through the hollow piston to the control orifice. After flowing through the control orifice the air passes to the lower part of the cylinder from which a connection is taken to the measuring head. When the measurement to be made is the displacement of a surface, a simple jet —Fig. 3(a)—may be used as the measuring head, the gap between jet and surface determining the effective escapement area for the air. The volume which determines the time constant of the instrument is that of the space in the cylinder below the piston

If you need

ALUMINUM CASTINGS for your DEFENSE PRODUCTION...

Send for this NEW BULLETIN

HOW Aluminum Industries, Inc., is supporting defense contract holders with first-class service on their aluminum castings needs is outlined in this new Bulletin No. 20-A.

The chemical and metallurgical laboratories, completely equipped for strict quality control . . . the pattern shop . . . the foundry with its 2,500,000 pounds monthly capacity (one of the largest in the United States) . . . the tool room, where skilled tool and die makers turn out precision work on the latest type machine tools . . . the engineering department staffed by engineers who from long specialized experience with aluminum know how to help you realize maximum benefits from the use of aluminum castings — these and other Aluminum Industries facilities for serving you are illustrated and described in this new bulletin.

If you are seeking a dependable, proven source of supply for aluminum castings made to your requirements, in any sizes and in any quantities, it will pay you to ask for our recommendations and quotations.

Bulletin No. 20-A is free to any defense contract holder who wants to be sure he can obtain the type of aluminum castings he needs to help keep his defense production moving smoothly. Send for it today.

PERMITE

ALUMINUM INDUSTRIES, INC.

CINCINNATI 25, OHIO

ALUMINUM PERMANENT MOLD, SAND and DIE CASTINGS...HARDENED, GROUND and FORGED STEEL PARTS

THOMAS
Flexible ALL METAL COUPLINGS
FOR POWER TRANSMISSION
REQUIRE NO MAINTENANCE

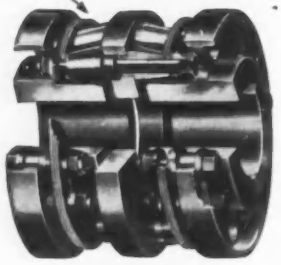
Patented Flexible Disc Rings of special steel transmit the power and provide for misalignment and end float.

Thomas Couplings have a wide range of speeds, horsepower and shaft sizes:
½ to 40,000 HP
1 to 30,000 RPM

Specialists on Couplings for more than 30 years

BACKLASH FRICTION WEAR and CROSS-PULL are eliminated
Lubrication is not required!

PATENTED FLEXIBLE DISCS



THE THOMAS PRINCIPLE GUARANTEES PERFECT BALANCE UNDER ALL CONDITIONS OF MISALIGNMENT.
NO MAINTENANCE PROBLEMS.
ALL PARTS ARE SOLIDLY BOLTED TOGETHER.

Write for the latest reprint of our Engineering Catalog.

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA

plus the capacity of the flexible tube and measuring head. The total effective volume is, therefore, small and the speed of response correspondingly high.

The piston is loaded by means of a compression spring S (Fig. 2). The initial compression of this spring is set by the "zero adjuster" screw so that, with a supply pressure of 15 psi, say, the piston just moves away from its lowest position when the pressure beneath the piston is 6 psi, i.e., $0.4P$. Any further increase in the pressure p will produce a proportional upward movement of the piston. The effective escapement area at the measuring head is dependent on the air gap and experiment has shown that the movement of the piston is directly proportional to the displacement of the surface from the measuring jet within the limits set by the condition that p lies between 6 psi ($0.4\ P$) and 13½ psi ($0.9\ P$). By suitable choice of control orifice and compression spring in the cylinder, the ratio of movement of piston to displacement at the measuring jet may readily be made equal to 1,000:1.

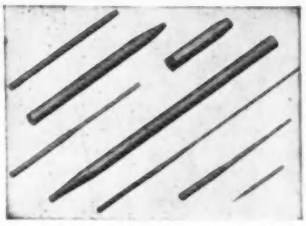
The movement of the piston is indicated on a 2 in. diameter dial gage of ordinary pattern, the pointer of which makes one revolution for a spindle movement of 0.1 in. The magnification provided by the dial gage is, therefore, about 60:1, so that a total magnification of the order of 60,000:1 for the complete unit may be achieved. With this sensitivity, using a dial gage having a scale of 100 divisions, each corresponding to a spindle movement of 0.001 in., one scale division would represent a relative displacement between measuring jet and surface of one millionth of an inch.

Alternative Forms of Measuring Head

Mention has been made of the use of a simple jet—Fig. 3(a)—as a suitable measuring head for the direct measurement of the displacement of a surface. Fig. 3(b) shows a sectional view of an alternative measuring head suitable for gaging the cross-sectional area of thread or wire. It is of box-like form with a shaped orifice in each of two opposite faces and is connected to the comparator by the tube entering the upper face. With properly dimensioned orifices "cross cornering" of the wire in the head has an inappreciable effect on the comparator reading.

A third form of measuring head for gaging thickness is illustrated in Fig. 3(c). Two jets are connected in parallel so that the effective area of escapement M at the measuring head

YOU SAVE
on parts made to your specifications by
TORRINGTON



You save time and money when you rely on our high productive capacity and special equipment to turn out precision parts to your order.

Typical are surgical and dental instruments, pen and pencil barrels, soldering iron cases, etc. Medium wall tubing up to 2½" O.D. and solid steel .015" to ⅜" diameter handled.

We are also set up to make such parts as special rollers, shafts, studs, dowel pins, special needles, instrument shafts and pivots, screw driver and ice pick blades, knurled mandrels and spindles, etc.

Send your prints and specifications today for prompt quotation.

THE TORRINGTON COMPANY
Specialty Department
554 Field Street • Torrington, Conn.

Makers of
TORRINGTON NEEDLE BEARINGS

"Gravy ON YOUR HAIR?"

Just because gravy goes swell over noodles, he shouldn't assume it's good on hair, too!

And just because one bearing is best lubricated by one particular grade of oil, you shouldn't assume that the same oil is best for *all* bearings on that machine. In many cases it isn't.

OIL CUPS permit you to lubricate each bearing with the oil best suited to that bearing—thus prolonging bearing life, reducing maintenance costs, cutting down-time, boosting production. And oil cups fortunately *cost very little.*

Gits oil cups have been the standard for industry for more than 40 years. Gits Bros. has the largest selection of oil cups available anywhere. Call on Gits Bros. for a prompt, efficient solution to your lubrication problems.

Write for free Catalog No. 60-A

GITS BROS. MFG. CO.

1838 S. Kilbourn Ave. Chicago 23, Illinois

Add EXTRA LIFE to machines and products!

WEAR-PROOF WITH

CARBOLOY®

CEMENTED CARBIDE

Keeps saws in line months longer!

Saw guides on saw setting machines took a terrific beating, resulting in costly downtime and maintenance. One saw manufacturer corrected this by wear-proofing the guide jaws with Carboloy Standard Blanks. Results: little or no downtime or maintenance!

Socket life increased 10 times!

Socket wrenches, used for driving hardened self-tapping screws, wore rapidly and slipped off the screw head, marring the product. The J. H. Williams Co. corrected this by using inserts of Carboloy cemented carbide. Life is increased at least 10 times over all-steel sockets; product scrap is greatly reduced.

Extra-accurate extra thousands of times!

Carboloy cemented carbide discs on the measuring faces of micrometers give greater accuracy, longer life. Scrap in the finished product is held down; frequent rechecking and refacing is eliminated.

WHAT better time to wear-proof with Carboloy cemented carbide than today, when machine and material conservation is so important?

Case history after case history proves that wear-resistant Carboloy cemented carbides combat wear, improve quality and increase the life of machine parts and products . . . increase it as much as 100 times in some cases!

Get your equipment rolling and keep it rolling for defense and essential civilian production. Wear-proof with Carboloy cemented carbide. Write, wire or phone:

CARBOLOY

DEPARTMENT OF GENERAL ELECTRIC COMPANY

11105 E. 8 Mile Road, Detroit 32, Michigan

"Carboloy" is the trademark for the products of Carboloy Department of General Electric Company.

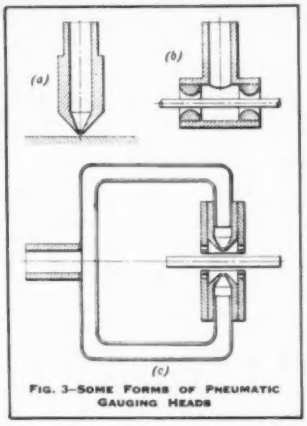


FIG. 3—SOME FORMS OF PNEUMATIC GAUGING HEADS

depends on the sum of the two escapement gaps formed between the jets and the material being measured. With this arrangement the reading of the comparator will, within certain limits, be independent of the location of the material between the jets since the sum of the two air gaps between jets and material will remain constant for a given thickness of material. The theoretical analysis briefly outlined above depends on the assumption that the coefficient of contraction for the air escaping at the measuring head remains reasonably constant. This will be the case unless the material is moved too close to one of the jets, when the coefficient of contraction for the air escaping from this jet may be reduced appreciably making the effective total escapement for the air at the measuring head less than before; the pneumatic gage will then indicate an apparent increase in the thickness of the material. To obviate this, a guard ring is fixed around each jet, as shown in Fig. 3(c), with the surface of the ring protruding slightly beyond that of the jet. If the material should touch the guard ring, air can still escape from the jet through holes drilled in the side of the measuring head as indicated in the diagram. The guard rings also provide mechanical protection for the jets.

The comparator described here has the advantages of simplicity in design and applicability in the workshop as well as in the inspection room. At its maximum sensitivity it may be used to measure displacements of the order of a few millionths of an inch. By changing the size of the control orifice, which can be done quickly and simply, the sensitivity can be reduced so as to provide for direct measurements up to a few thousandths of an inch.

OUR READERS SAY

Stresses in Rotating Disks

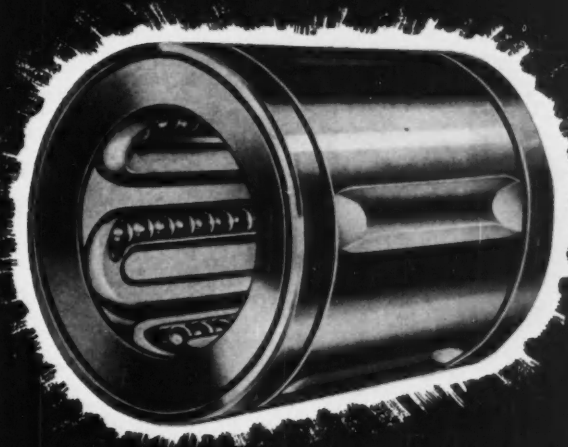
To the Editor:

After reviewing the article "Stresses in Rotating Disks" by T. H. Gawain and E. C. Curry appearing in the July number of PRODUCT ENGINEERING, page 152, I feel certain comments and additions must be made in order to extend and clarify your readers' understanding of this type of problem.

Without personal comments regarding the ease of solution as presented, the statement that this method of calculation yields answers differing by less than 1 percent from exact theoretical values is misleading. Since this is a step-by-step solution, predicted on approximating the actual disk profile by a series of constant thickness cylinders, the answers obtained will depend on how well the actual disk profile can be approximated and on the judgment of the person performing the calculation. On the other hand, however, the question arises as to whether or not a theoretical accuracy of 1 percent holds any physical meaning and if an accuracy of 1 percent or even 5 percent is necessary. If a disk is stressed at a low value, 1, 5, or even 10 percent accuracy is of relatively minor importance since machining tolerances of the disk profile and the fact that blade loading does not impose uniform radial load on the disk rim (in the case of turbine rotors) more than accounts for this magnitude of error. If the disk is highly stressed, the same comments apply, but in addition any local stresses above yield will redistribute themselves, and the disk will only fail when the average tangential stress of the entire disk equals the yield of the material.

In the article, as presented, no mention is made of the effect of radial temperature gradient along the disk. It is agreed that in the case of flywheels and steam turbines, certain compressors, the disk runs at a constant radial temperature. In the case of high performance gas turbines, turbo superchargers, reversing steam turbine, and many other cases, a radial temperature gradient does occur either due to cooling on the disk in order to maintain physical properties, or merely by the actual application. These gradients have a very serious effect on the stress distribution of a disk and cannot be ignored. The writer has taken

BALL BUSHING



The BALL BEARING for your

LINEAR MOTIONS

Sliding linear motions are nearly always troublesome. Thousands of progressive engineers have solved this problem by application of the Precision Series A BALL BUSHINGS.

And now hundreds of original equipment manufacturers use the low cost Commercial Series B BALL BUSHINGS which were developed for support of linear motions in competitively priced, volume manufactured products where super precision is not essential.

Alert designers can now make tremendous improvements in their products by using BALL BUSHINGS on *guide rods, reciprocating shafts, push-pull actions,* or for support of *any mechanism that is moved or shifted in a straight line.*

Improve your product. Up-date your design and engineering with BALL BUSHINGS!

LOW FRICTION • LONG LIFE
ELIMINATES BINDING AND CHATTER
SOLVES SLIDING LUBRICATION PROBLEMS
LASTING ALIGNMENT • LOW MAINTENANCE

Now manufactured for 1/4", 1/2", 3/4", 1" and 1 1/2" shaft diameters.

Write for descriptive literature and the name of our representative in your city

THOMSON INDUSTRIES, INC., Dept. F
MANHASSET, NEW YORK

PROGRESSIVE MANUFACTURERS USE BALL BUSHINGS—
A MAJOR IMPROVEMENT AT A MINOR COST

if

your product calls for trouble-free power transmission it calls for · · · · ·

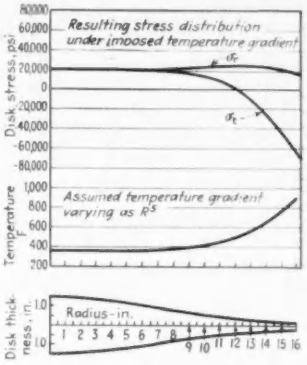
Perkins *custom-made* Gears

PERKINS MAKES TO CUSTOMERS' SPECIFICATIONS IN ALL MATERIALS, METALLIC AND NON-METALLIC: *bevel gears, ratchets, ground thread worms, spiral gears, worm gears, helical gears, spur gears with shaved or ground teeth.*

Perkins
Machine & Gear
company
west springfield
massachusetts

the liberty of imposing a reasonable temperature gradient on the disk used as an example in the article, and by using the method described in his paper "Centrifugal and Thermal Stresses in Rotating Disks", *Journal of Applied Mechanics*, December 1948, has calculated the new stress distribution for the example.

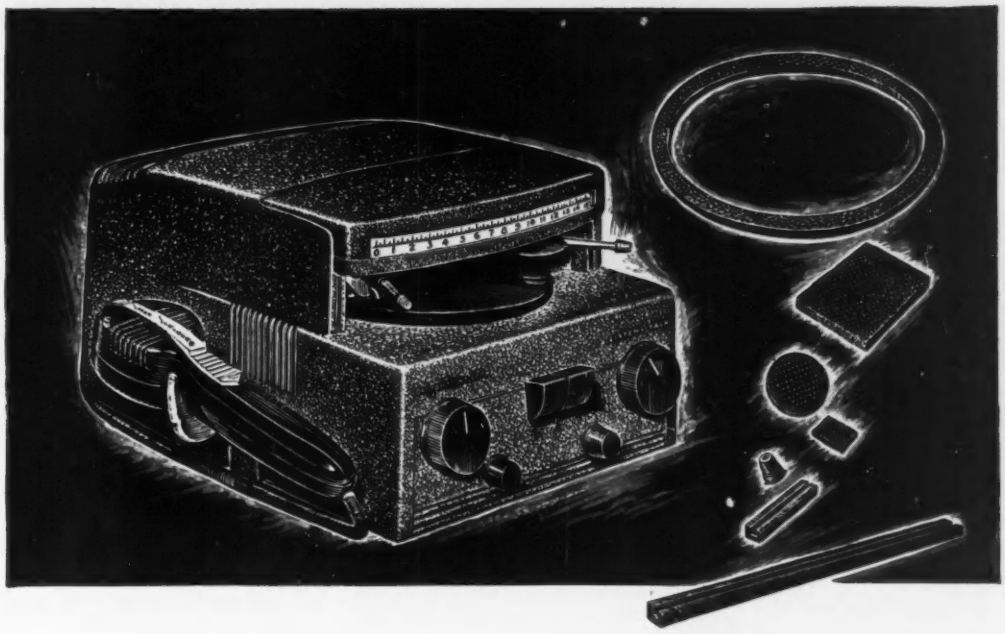
As shown in Fig. 1, a temperature gradient of 900 deg F at the rim to 350 deg F at the center of the disk has



been imposed and the resulting stress distribution changed from the constant stress of 15,000 psi originally calculated to the distribution shown having a compressive value of tangential stress of approximately 72,000 psi at the rim and 20,000 psi tension at the center. The magnitude of these values clearly indicates that design of disks must be a compromise between those stress values obtained under constant radial temperature conditions and those obtained when considering a radial temperature gradient. Assuming that it is evident that the way to strengthen a disk operating in a constant temperature field is to add mass at the hub, it can be seen that since a temperature gradient which decreases from rim to hub (most commonly encountered) puts compressive values of stress toward the rim, the way to counteract this, up to certain limits, is to allow greater values of tensile stress to occur at the rim under the no-temperature condition. This is accomplished by weakening the hub, or removing mass, so that the greater value of tensile stress counteracts the compressive stress and the resultant value is maintained within desired limits. Here certain conclusions may be made:

1. To increase the strength of a disk operating under radial temperature conditions, directly opposite steps must be taken from those necessary to strengthen it when operating without the gradient.

2. A slight temperature gradient is



SoundScriber screens noise and prevents damage to delicate parts with

SPONGEX®

CELLULAR RUBBER

TURNTABLE CUSHION — prevents transmission of motor vibrations to recording disc. Cushion permits clear, noise-free recording. ***A custom-molded Spongex part.***

AMPLIFIER INSULATOR — provides wall of insulation between plug-in amplifier and main electrical chassis. ***Part is die-cut Spongex sheet stock.***

HAND MICROPHONE SPACERS — microphone element "floats" between rubber spacer cushions. These spacers protect the element from damage, and insulate it against transmitting the sound that would otherwise result from dropping or banging the microphone. ***Spacers are die-cut Spongex sheet stock.***

MOTOR SHOCK ABSORBERS — absorb shock in motor suspension and dissipate motor vibration. ***Custom-molded Spongex.***

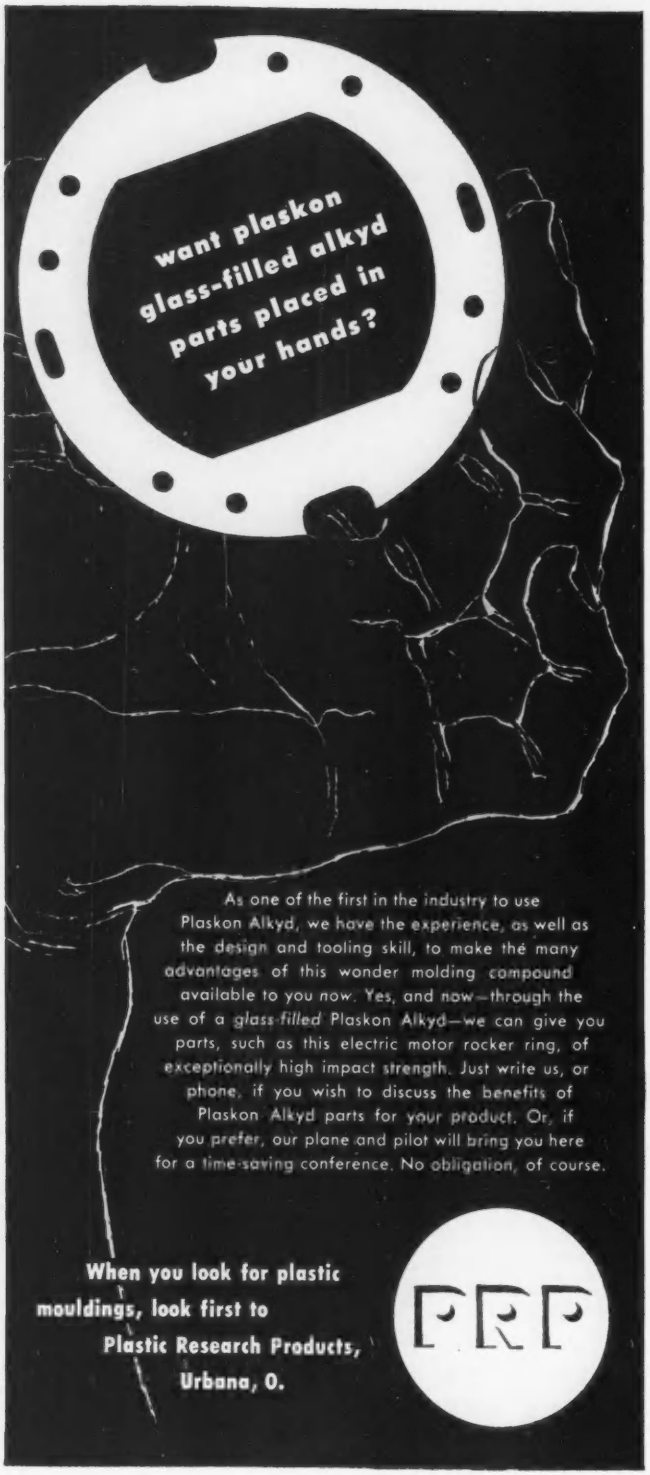
AMPLIFIER GASKET — protects the amplifier from damage should machine be banged about, as often happens on business trips. ***Custom-molded Spongex.***

This new booklet on the properties of, test data on, and specifications for cellular rubber has just been released. It's concise, and a valuable reference source. Write for a free copy today.

The World's Largest Specialists in Cellular Rubber

THE SPONGE RUBBER PRODUCTS COMPANY

402 DERBY PLACE — SHELTON, CONN.


want plaskon glass-filled alkyd parts placed in your hands?
As one of the first in the industry to use Plaskon Alkyd, we have the experience, as well as the design and tooling skill, to make the many advantages of this wonder molding compound available to you now. Yes, and now—through the use of a glass-filled Plaskon Alkyd—we can give you parts, such as this electric motor rocker ring, of exceptionally high impact strength. Just write us, or phone, if you wish to discuss the benefits of Plaskon Alkyd parts for your product. Or, if you prefer, our plane and pilot will bring you here for a time-saving conference. No obligation, of course.
When you look for plastic mouldings, look first to Plastic Research Products, Urbana, O.
PRP

beneficial since the compressive values of tangential stress obtained tend to countercounteract and minimize the tensile values due to rotation.

3. Large temperature gradients impose large values of compressive stress in the disk which can only be counteracted by allowing the disk to expand under centrifugal force.

4. Low values of modulus of elasticity and coefficient of expansion result in lower values of thermal stress.

It is hoped that the foregoing will aid your readers in understanding the problem of rotating disks and that some clarification has resulted in the use of the many various methods proposed as solutions for this type of problem. —W. R. LEOPOLD
Eclipse-Pioneer
Div. of Bendix Aviation Corp.

Corrosion Article Requested

To the Editor:

Please send me the article, "Corrosion Factors in Design", by Fred M. Reinhart presented in the July edition. In addition may I have copies of pages 158 and 159.

The article in question is of deep interest to us at the moment since we have an application where a galvanic corrosion occurs, and this article will give us some pointers in obtaining the cure. —THOMAS M. HARROWER
Milwaukee Resistor Co.

Metal Coverage

To the Editor:

I have noted with great interest the feature "Materials Availability Trends" in your August 1951 issue.

This type of development is certainly most interesting, and I am wondering if you plan any similar items on aluminum. —GEORGE PERKINS
Reynolds Metals Co.

Ed—This is a regular monthly feature of our magazine. We have a little information on aluminum in our September issue also. From time to time we will continue to publish pertinent information on the availability of this material. Our October issue has a 24 page insert covering the availability in properties of all metals.

Attention: P.K.

To the Editor:

We are desirous of obtaining the name of the person inquiring about "Telephone devices" and a "Small devices called an opera glass", which

POWDER METALLURGY
Conserves Materials

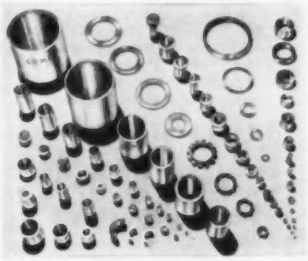
As the channeling of strategic metals into essential applications takes on increasing importance, the material-conserving advantages of powder metallurgy processes are receiving added attention.

In powder metallurgy, parts are die-formed to their final dimensions within extremely close tolerances. This does away with the need for machining operations which result in scrap metal.

INTRICATE SHAPES

The advantages of the powder metallurgy process are of particular importance in the production of intricate structural shapes, which would normally involve extensive and complex machining, with a large amount of scrap. Gears, cams and many other parts are successfully produced, without machining, by the powder metallurgy process.

In addition to making most effective use of critical materials, the powder metallurgy process, by eliminating costly machining, reduces unit cost to the purchaser. Since the production of special shapes requires tooling, the low-cost advantage is most marked in high-volume work, where initial tooling charges are offset by subsequent savings in unit costs.



Parts such as these can be produced by the powder metallurgy process, without machining operations that result in metal scrap and increased unit costs.

COMPOSITIONS AVAILABLE

Bearings and parts can be produced in any one of a number of compositions of "COMPO" (porous bronze) or "POWDIRON" (sintered iron) either with or without self-lubrication. Detailed information may be obtained from the manufacturer, Bound Brook Oil-Less Bearing Company, Bound Brook, N. J.

(Advertisement)

Strategic Materials S-T-R-E-T-C-H Farther in "COMPO"® and "POWDIRON"®

BEARINGS AND PARTS

When hard-to-get metals are processed by Bound Brook powder metallurgy to form "COMPO" (porous bronze) and "POWDIRON" (sintered iron) bearings and parts, there's no waste of strategic materials. The metals go *farther*, to serve Bound Brook customers *better* — and to aid the defense program.

"COMPO" and "POWDIRON" bearings and parts need no machining, leave no scrap — at Bound Brook or on the user's assembly line.

For latest list of stock sizes of "COMPO" bearings, write us on your company letterhead. Consult our Engineering Department on parts and special bearings.

SEND FOR THIS FREE BOOKLET TODAY

BOUND BROOK

OIL-LESS BEARING COMPANY

BOUND BROOK, N. J. • BOUND BROOK, CALIF.

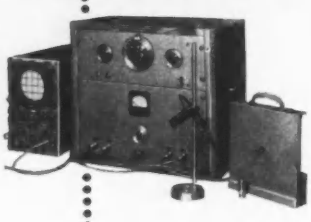
"COMPO" • "POWDIRON" • "BOUND BROOK"

ESTABLISHED 1883

NOW! measure Young's modulus of elasticity

BY MEANS OF SOUND VIBRATIONS

Determines Resonant Frequency of Any Mass for Structural Strength



NEW ELECTRO Sonometer

Easily measures torsional and flexural characteristics of any material or solid mass. The mechanical driver is placed at one end of the sample under test and the pick-up at the other. Power is fed into the driver causing sample to vibrate. The pick-up converts this vibration into electrical energy, and as oscillator is tuned to proper frequency, the point of resonance is shown by the meter. Mode of vibration and phase relationship are viewed on a cathode ray oscillograph.

FOR TESTING
Aluminum
Carbon Electrodes
Castings
Concrete
Ceramics
Pressed Materials
Plastics
Metal
Wood
Many Others

Send Coupon Today for Detailed Bulletin

ELECTRO PRODUCTS LABORATORIES
4501-PE Ravenswood Ave., Chicago 40, Ill.

Name
Firm
Street
City State

Precision Instruments Since 1944

Makers of the LINEAR PRESSUREGRAPH

Electro ELECTRONIC EQUIPMENT

Measures, records explosion, gas or hydraulic pressure in jet or internal combustion engines, compressors, pipe lines and injection pumps.

SALES ENGINEERS IN PRINCIPAL CITIES

were mentioned on page 236 of PRODUCT ENGINEERING for August, 1951. The initials of the person inquiring are P. K.

We are in a position to furnish this material referred to in the article, and shall be waiting for a reply from you at your earliest convenience.

Should the use to which the above mentioned equipment violate ethical practice, it would not, of course, be supplied. —DONALD F. PENNIE
The Maico Co., Inc.

Article on Product Colors

To the Editor:

Congratulations on your article in the August issue of PRODUCT ENGINEERING entitled "How to Plan Product Colors," by Howard Ketcham. As an industrial designer, I have long been an advocate of functional color decoration and it is gratifying to see such printed support of my views.

At last engineers are beginning to realize the value of honesty in decoration. Steel panels never did make good looking mahogany.

Although the consuming public is often victimized by sales psychology, this is unquestionably one application where it can be applied to increase human comfort and safety.

—A. JENSEN MORAN
Los Angeles, Calif.

For Measuring Color Intensity

To the Editor:

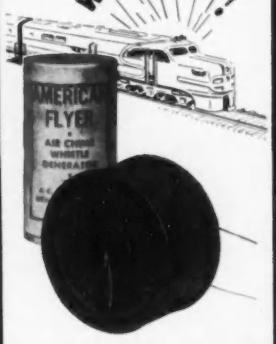
We are in the market for some sort of apparatus that will indicate the intensity of color. The instrument should be able to register the variations in red color from light to dark shades. In our application it could be used to match the exterior colors of our candles. —B. L. ROBERTSON
Candle Craft, Inc.

Ed—There are several ways that you could tackle this problem. One would be to obtain a recording Spectrometer. This instrument is a very accurate one and is used in photometric work by the various lamp companies. Initial cost is approximately $11,000-12,000. Manufacturers include General Electric Co., Apparatus Div., Schenectady, N. Y.; and Beckman Lab., Los Angeles, Calif.

You could also obtain colorimeters, which are very much less expensive instruments but will only let you measure ratios of three basic colors, and we suspect that you want something more accurate.

We suggest that you obtain porcelain enamel samples or brass samples

THE SECRET OF THE WHOO-O-O-O!



... A TRIBUTE TO ALERT PRODUCT ENGINEERING

Highly competent young experts set a fast pace for product design engineers who work in the toy and model fields.

That is why A. C. Gilbert's famous American Flyer scale model railroad equipment is true to life right down to the rivet heads . . . and the latest Nathan Air Chime whistle on the locomotives.

The Wheeler Insulated Wire Company's part in this picture concerns that air chime whistle. For the secret of the "whoo-o-o-o!" is a tiny speaker powered by a modified Wheeler phone coil unit that excludes audible response to the 60 cycle train operating currents, but faithfully and dependably reproduces the special high frequency whistle note impulses.

We helped A. C. Gilbert engineers solve this problem successfully and quickly . . . at low unit costs that are a key factor in a highly competitive field.

We invite you to talk over your problem with Wheeler Specialists.

WHEELER
Specialized
COMMUNICATIONS COMPONENTS

Sound Powered TELEPHONES and HANDSETS

THE WHEELER INSULATED WIRE CO., Inc.
Division of the Sperry Corp.
1103 EAST AURORA ST.
WATERBURY 20, CONN.
13WHB1

in the various colors that you want. You can have these rated by one of the testing labs such as the Bureau of Standards, who would either do the job or advise you as to who else would. Colors on both brass and porcelain would be permanent and you could use such samples in your plant in checking shading.

Dr. Little at Electrical Testing Labs, Spectometric Div., New York City, is an expert on color measurement and can give you much more sound advice than we.

Non-Circular Gear Design

To the Editor:

I am confronted with the problem of designing non-circular gears for use in computing machines. I understand that a series of articles were written by J. J. Pesqueira in 1936 and 1937 entitled "Principles of Design for Non-Circular Gears." Below is the list of articles I would like to obtain: Part I, General Considerations and Equations—Dec. 1936; Part II, Velocity and Acceleration Equations—Jan. 1937; Part III, Elliptical Rolling Curves—Feb. 1937; and Part IV, Kinematics of Elliptical Gears—Mar. 1937.

I would appreciate hearing from you as soon as possible about the availability of these articles.

—WILFORD C. WILDE
Military Physics Research Lab.
University of Texas

Ed—Although tear sheets are not available, we are sending you photostatic copies of all of these articles. We trust that they contain the information for which you are looking.

It's Still New!

To the Editor:

In the March 1951 issue of PRODUCT ENGINEERING, you published a very interesting article on 10 types of splines.

I am interested in the two types illustrated in figures 9 and 10. We should be glad if you can advise us as to whether these types of splines have been in common use prior to 1948.

All information that you can give us will be appreciated. —A. H. HEIR
Manco Ltd.
Birmingham, England

Ed—The type of face spline illustrated in Fig. 9 called radial serrations has been used for some time. This type of coupling has often been re-

WHAT ARE YOUR INDIVIDUAL NEEDS FOR A

HEAT EXCHANGER COOLER or CHILLER

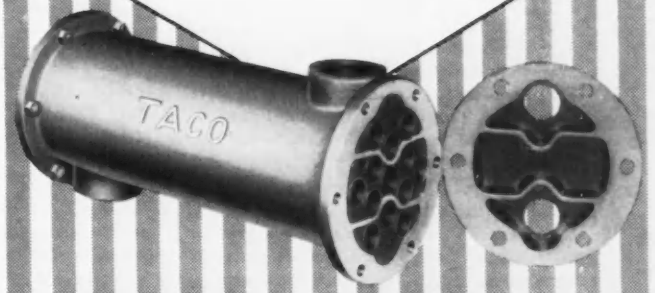
WHAT SHAPE? WHAT TYPE? WHAT MATERIAL?

for heating or cooling...

WATER • HYDRAULIC OILS • LUBRICATING OILS
COOLANTS • CUTTING OILS • OTHER LIQUIDS

Our engineering department will gladly assist you, just as it has numerous other organizations, in design and selection of proper exchanger for your particular requirements.

A heat exchanger specialist from the factory is immediately available. Just call Providence, R. I., GAspee 1-2600, wire or write.



Illustrated is just one of more than 100 different shapes we are making as component parts for manufacturers.

TACO HEATERS INCORPORATED
137 South St., Providence 3, R. I.

CAN CARBON BE SOLDERED TO METAL?
The answer is YES! ... and this new Stackpole method cuts costs and adds efficiency to a lot of brush, contact and friction device applications

Now Stackpole can solder carbon brushes, contacts or friction devices directly to their metal supports!

Carbon brushes, for instance, can be silver soldered to leaf springs, thus eliminating brush holders and shunts. Carbon contacts can be soldered directly to metal arms. Carbon friction discs can be soldered directly to metal backing plates—and so on through an interesting range of possibilities. You gain all of the advantages of carbon—*without the need for costly fixtures for bolting or clamping it in place!* There are some limitations on size. Send details of your application for recommendation by Stackpole engineers.

STACKPOLE CARBON COMPANY, St. Marys, Pa.

STACKPOLE

Everything in Carbon but Diamonds

ferred to as a Hirth joint since it has been used extensively by that company in Germany.

The face spline illustrated in Fig. 10 called the "Curvic Coupling" has been developed by the Gleason Works in Rochester, N. Y. The teeth on this spline are cut with a special machine that is manufactured by this company. This spline has been used prior to 1948, however, in a relatively few instances.

If you care for more data contact the Gleason Works directly.

Special Casting Dimensions

To the Editor:

We would appreciate knowing if you have published any information on a standardized method of dimensioning drawings of cast parts primarily from the standpoint of subsequent machining to accurate dimensions. Comments on the following points would be helpful:

a. The use of "starting" dimensions in one or more planes to assist in locating the casting during the first machining operation.

b. The establishment of an initial reference plane for further work and for ease of inspection.

c. The use of lugs and bosses that are non-functional, that might be removed later, and that assist in location during machining and inspection.

d. Dimensioning "across" the parting line of a sand or die-cast part.

e. The question (desirable or undesirable) of locating a machined surface from more than one cast surface.

f. The effect of proper dimensioning on tools, jigs, and fixtures.

We believe that attention given to this problem during design will save considerable time and expense during fabrication and inspection. For this reason we would welcome any references to articles and texts, or to any organization that you believe has given special attention to this subject.

—EDWARD B. SCHOFIELD
General Precision Laboratory

Ed—Frankly, we have never treated the subject of castings exactly from this standpoint. Perhaps we have been missing the boat.

The concerns that we suggest for information of this sort are as follows: Gray Iron Founders' Society, Cleveland, Ohio, which has a book on gray iron castings; the Meehanite Corp., New Rochelle, New York, for information on sand castings; die castings the New Jersey Zinc Co., 160 Front St., and the Doehler-Jarvis Corp., 386 Fourth Ave., New York.

They never miss this HEADLINE

and the savings in time — and screws — make news wherever they see it on P-K Size-marked Gear Grip Socket Head Cap Screws

The SIZE-MARK on Parker-Kalon Socket Head Cap Screws is something no workers can miss, whether they are beginners or veterans.

When they see it, errors and confusion are avoided. Sizes are issued correctly, used correctly—there's no time wasted checking and changing, no spoiled work.

In the tool-crib, the P-K Size-mark speeds up sorting of left-over, mixed screws, without the bother of "miking" or gauging. It puts screws back in use that might otherwise be discarded because sorting is "too much bother".

Only Parker-Kalon offers the Size-mark and Gear Grip on Cap Screws. They are wanted, in tremendous quantities, for more of industry's finest products than ever before. For DO or other assemblies, set your standards by P-K quality. Your P-K Distributor will apply his long experience to your most difficult problems of planning and procurement.

IF IT'S P-K IT'S O.K.

Parker-Kalon Corporation, 200 Varick Street, New York 14, New York.
Sold through Accredited Distributors.

PARKER-KALON®

Cold-forged

SOCKET SCREWS

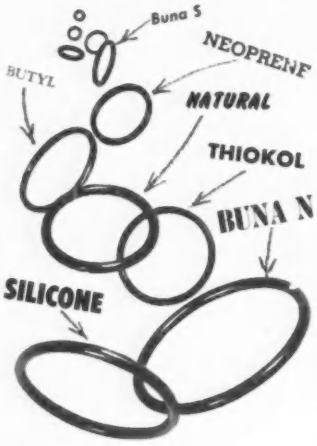
SIZE-MARKED SOCKET HEAD CAP SCREWS • GROUND THREAD SOCKET SET SCREWS
FLAT HEAD SOCKET CAP SCREWS • STRIPPER BOLTS • PIPE PLUGS • HEX KEYS

MORE HELP FOR ASSEMBLY PLANNERS

The New
P-K Socket Screw Dimension Finder

A pocket-size plastic slide chart gives you all essential dimensions of P-K Socket Cap Screws, Set Screws, Flat Head Socket Cap Screws, Stripper Bolts, and Pipe Plugs. Includes Set Screw Point Dimensions, and Thread Length Formula. Available, FREE from your P-K Distributor.

SPECIAL 'O" RINGS



Many modern mechanisms present designers with new and difficult sealing problems created by unusual operating conditions. Frequently, special "O" rings are required, to insure a reliable seal in applications where extremes of temperature or very high pressures are encountered, or where the seal is exposed to fluids, gases, or chemicals which would damage a standard ring. Precision "O" rings moulded from Arrowhead special compounds have solved countless critical sealing problems. If you have a tough one, your inquiry is invited. It will receive the personal attention of our Director of Engineering Research.

GET THESE VALUABLE ENGINEERING AIDS

1. "O" RING MANUAL — *Contains illustrated design information and data on the selection, installation and proper use of "O" rings.*

2. DATA SHEETS — *Work sheets to assist designers in the selection of proper ring and most suitable compound, or in determining cause of "O" ring failure. Provides expert technical advice at no obligation.*

Write Dept. R-2

ARROWHEAD RUBBER COMPANY
DOWNEY (Los Angeles County) CALIF.
A DIVISION OF NATIONAL MOTOR BEARING CO., INC.

NEW BOOKS

Fundamentals of Atomic Physics

SAUL DUSHMAN, *Ph.D., Research Consultant, Formerly Assistant Director Research Laboratory, General Electric Co., Schenectady, N. Y.* 294 *pages,* 6 x 9 *in. Published by McGraw-Hill Book Co.,* 330 *W. 42nd St., New York* 18, *N. Y.* $5.50.

The first four chapters comprise a preliminary review of college physics and mathematics. The history of physical science is traced from the days of Pythagoras and Aristotle thru Newton, who receives special attention, to the present time. Each major contribution to the science is discussed briefly and its mathematical representation is presented. After a brief review of college mathematics, a comprehensive study of the kinetic theory of gases and molecular activity is offered. Special significance is given to the derivation and use of Avogadro's number.

Chapters 5 to 9 offer an explanation and mathematical analysis of electron qualification, production and activity. Special treatment is given to the production and defraction of X-rays.

From chapter 9 to 14 the nuclear theory of atomic structure is introduced and extensively discussed. Among the important subjects considered are: spectral analysis of elements and energy level of atomic components; periodic arrangement of the elements; analysis of the hydrogen molecule; definition, discovery and peculiar nuclear structure of isotopes; the phenomena of radio-activity; artificial transmutation of elements; discovery characteristics and production of neutrons and other nuclear particles; origin of stellar energy and production of atomic energy.

Chapter 14 explains the theory and operation of the various types of high voltage generators and accelerators now in use. Diagrams and sectional drawings are given to show the working principles and construction of these machines.

Nomographic Charts

C. ALBERT KULMANN. 244 *pages,* 7 x 10 *in. Published by McGraw-Hill Book Co.,* 330 *W. 42nd St., New York* 18, *N. Y.* $6.50.

A collection of 92 nomographic charts that the author has used for

30-DAY DELIVERY!
SIMPLEST... MOST COMPACT

O-M
AIR HYDRAULIC WATER CYLINDERS

Add up these advantages. They are the reasons why more and more equipment manufacturers are specifying Ortman-Miller cylinders for all types of applications.

Simplicity of design eliminates tie rods and bulky end caps . . . saves one-third in installation space. All parts and mounting brackets interchangeable bore for bore. Cost less to buy, install and service. Full range of sizes (1½" to 8" bores) *available for early shipment.* Machined steel (no castings) and bearing bronze throughout.

Write today for details! Speed production, cut costs and save space with Ortman-Miller cylinders.

FREE TEMPLATES

For the first time in the industry, O-M offers a complete set of templates showing all cylinders and mounting brackets. ½ scale. Your set on request.

ORTMAN-MILLER
MACHINE CO., INC.
1215 150th Street Hammond, Indiana

many years to effect savings in time in the routine work of his office. The volume is not intended to be an engineering handbook, nor a textbook covering the theory and technique of graphical representation. Neither is it offered as giving the best possible graphical methods for the solution of the problems covered.

The greatest value of these charts is in the timesaving that can be achieved by obviating the need for looking up in numerous tables the values of the various items that enter into a problem. For instance, where the factors that enter into a problem may be modified by exponential functions, or varying empirical multipliers, or similar variations, the chart scalings have taken them into account; thus reference to tables or auxiliary curve sheets is unnecessary. The charts are of particular value where the factors may involve odd exponential functions or empirical factors based upon the relationship between two or more of the basic factors.

Most of the charts are intersection or combination intersection and alignment nomographs; they are more accurate than normal slide rule computation. Each chart occupies a full page and is accompanied by sufficient text to explain how solutions of specific problems can be obtained.

The charts are grouped in six classifications: Function scales, general charts, hydraulic charts, mechanic charts, thermo-dynamics charts, and electrical charts.

Classical Mechanics

HERBERT GOLDSTEIN, *Ph.D., Harvard University. 399 pages, 6 x 9 in. Published by Addison-Wesley Press, Inc., Cambridge 42, Mass.* $7.

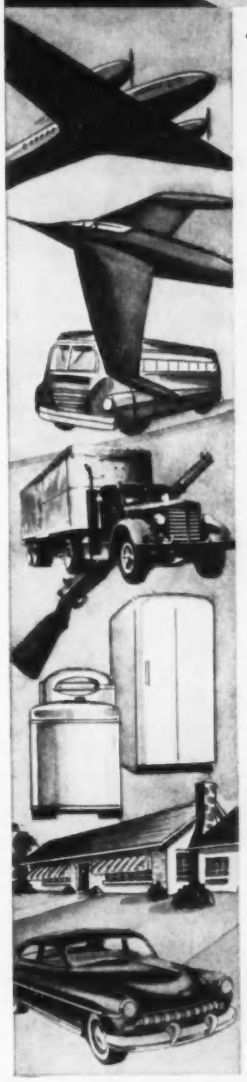
An advanced course in classical mechanics has long been a time-honored part of the graduate physics curriculum. The present-day function of such a course, however, might well be questioned. It introduces no new physical concepts to the graduate student. It does not lead him directly into current physics research. Nor does it aid him, to any appreciable extent, in solving the practical mechanics problems he encounters.

Despite this arraignment, classical mechanics remains an indispensable part of the physicist's education. It has a twofold role in preparing the student for the study of modern physics. First, classical mechanics, in one or another of its advanced formulations, serves as the spring board for the various branches of modern phys-

CHEMICALS ACP PROCESSES

phosphate coating chemicals

TO MAKE YOUR PRODUCT DURABLE



PAINT BONDING

"GRANODINE"® forms a zinc-iron phosphate-coating bond on sheet metal products—automobile bodies and fenders, refrigerator cabinets, etc.—for a durable, lustrous paint finish.

"LITHOFORM"® makes paint stick to galvanized iron and other zinc and cadmium surfaces.

"ALODINE",® the new ACP protective coating chemical for aluminum, anchors the paint finish and protects the metal.

RUST PROOFING

"PERMADINE",® a zinc phosphate coating chemical, forms on steel an oil-adsorptive coating which bonds rust-inhibiting oils such as "Granoleum."

"THERMOIL-GRANODINE"® a manganese-iron phosphate coating chemical, forms on steel a dense crystalline coating which, when oiled or painted, inhibits corrosion.

PROTECTION FOR FRICTION SURFACES

The oiled "THERMOIL-GRANODINE" coating on pistons, piston rings, cranks, camshafts and other rubbing parts, allows safe break-in operation, eliminates metal-to-metal contact, maintains lubrication and reduces the danger of scuffing, scoring, galling, welding and tearing.

IMPROVED DRAWING AND COLD FORMING

"GRANODRAW"® forms on pickled surfaces a tightly-bound adherent, zinc-iron phosphate coating which facilitates the cold mechanical deformation of steel, improves drawing, and lengthens die life.

Send for descriptive folders and Government specifications chart on the above chemicals. Write or call for more information on these products, and advice on your own metal-working problem.

Pioneering Research and Development Since 1914

AMERICAN CHEMICAL PAINT COMPANY

AMBLER, PA.

Manufacturers of Metallurgical, Agricultural and Pharmaceutical Chemicals

ORDER SEWALL SPROCKETS

right out of the catalog

TYPE A
Plate Sprocket —no hubs

TYPE B
Hub Projection —one side

TYPE C
Hub Projections —both sides

TYPE D
Plate Sprocket —cast iron hub

If your product calls for any of these roller chain sprockets as diagramed, the new Sewall Stock Sprocket Catalog can save you time and money. *May we send you a copy?*

Sewall sales engineers will welcome your inquiry on any type of custom-built cut tooth gears . . . racks . . . all types of sprockets.

St. Paul: NEstor 1381

SERVICE OFFICES IN ST. PAUL AND CHICAGO

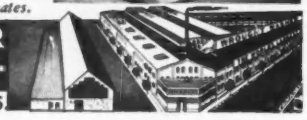
E. B. SEWALL MANUFACTURING CO.
696 Glendale St. • St. Paul 4, Minnesota

Since 1887

MILWAUKEE WROT WASHERS

Better WASHERS ... Competitively Priced

Large volume production, the most advanced methods and facilities, plus more than 60 years of continuous experience in the manufacture of Washers, are factors that enable us to offer you top quality washers and stampings at competitive costs. Over 22,000 sets of dies for making Washers of every type (Standard and Special), from every type of material, for every purpose, in any finish. STAMPINGS of all descriptions; Blanking, Forming, Drawing. *Submit your blueprints and quantity requirements for estimates.*



WROUGHT WASHER MANUFACTURING CO.
The World's Largest Producer of Washers
2213 S. BAY ST., MILWAUKEE 7, WIS.

ics. Thus, the technique of action-angle variables is needed for the older quantum mechanics, the Hamilton-Jacobi equation and the principle of least action provide the transition to wave mechanics, while Poisson brackets and canonical transformations are invaluable in formulating the newer quantum mechanics. Secondly, classical mechanics affords the student an opportunity to master many of the mathematical techniques necessary for quantum mechanics while still working in terms of the familiar concepts of classical physics.

This book is an exposition of classical mechanics which fulfills the new requirements. Those formulations which are of importance for modern physics have received emphasis, and mathematical techniques usually associated with quantum mechanics have been introduced wherever they result in increased elegance and compactness. For example, the discussion of central force motion has been broadened to include the kinematics of scattering and the classical solution of scattering problems. Considerable space has been devoted to canonical transformations, Poisson bracket formulations, Hamilton-Jacobi theory, and action-angle variable. An introduction has been provided to the variational principle formulation of continuous systems and fields. As an illustration of the application of new mathematical techniques, rigid body rotations are treated from the standpoint of matrix transformations. As a consequence, such diverse topics as the inertia tensor, Lorentz transformations in Minkowski space, and resonant frequencies of small oscillations become capable of a unified mathematical treatment. Also, by this technique it becomes possible to include at an early stage the difficult concepts of reflection operations and pseudotensor quantities, so important in modern quantum mechanics.

Several additional departures have been made. All too often, special relativity receives no connected development except as part of a highly specialized course which also covers general relativity. However, its vital importance in modern physics requires that the student be exposed to special relativity at an early stage in his education. Accordingly, Chapter 6 has been devoted to the subject. Another innovation has been the inclusion of velocity-dependent forces. Historically, classical mechanics developed with the emphasis on static forces dependent on position only, such as gravitational forces. On the other hand, the velocity-dependent electromagnetic force is constantly encountered in modern physics. To enable the student to

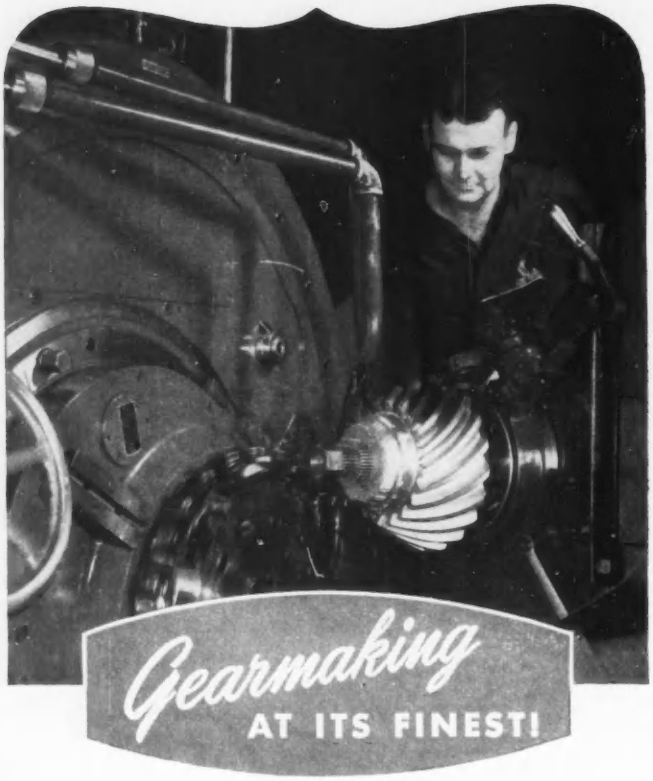
CONTINENTAL SCREW COMPANY
INC. ★ 1904

You can count on Continental

CONTINENTAL SCREW COMPANY
New Bedford, Mass.

Manufacturers of famous HOLTITE-Phillips and Slotted Head
Screws and Bolts and Allied Fastenings, both Special and Standard

HOLTITE *Engineered* FASTENINGS



HERE "under one roof" at FAIRFIELD is *everything* needed for producing fine gears — metallurgical department, batteries of the most modern machines, testing laboratories, complete heat-treating facilities — all operated by skilled craftsmen working under expert engineering supervision. By specializing exclusively in "FINE GEARS MADE TO ORDER" for more than thirty years, FAIRFIELD has become one of America's largest producers of these parts. This is why many makers of construction machinery . . . agricultural implements . . . machine tools . . . military equipment . . . tractors, trucks, and buses now regularly depend on FAIRFIELD to meet their requirements. *For the Best in Gears, Specify Fairfield!* FAIRFIELD MANUFACTURING CO., 313 So. Earl Ave., Lafayette, Indiana.

handle such forces as early as possible, velocity-dependent potentials have been included in the structure of mechanics from the outset, and have been consistently developed throughout the text.

Production Forecasting, Planning, and Control

E. H. MAC NIECE, *Director of Quality Control, Johnson & Johnson, New Brunswick, New Jersey.* 305 *pages,* 6 x 9 *in. Published by John Wiley & Sons, Inc., New York; Chapman & Hall, Ltd., London.* $5.50.

This book is unique because it gives an elementary, integrated treatment of all three inseparable factors of production—forecasting, planning and control.

Unusual in approach, the book reduces methods and techniques to a set of principles, then illustrates these principles with specific examples of effective applications. While it covers the subject from the engineering viewpoint, it supplements this treatment with material on social and economic implications. This is necessary, the author maintains, because successful forecasting, planning and control depend on their correlation with human and economic welfare.

Two chapters present a problem covering all factors in the forecasting, planning, and control of a small, but essentially complete enterprise, and the solution of this problem.

Particularly valuable in these troubled times is the final chapter, "War Production Forecasting, Planning and Control," outlining problems peculiar to industry as it prepares or produces for a "military" economy.

Industrial Electronic Control

W. D. COCKRELL, *Industrial Engineering Divisions, General Electric Co.* 385 *pages,* 5¾ x 8 *in., Published by McGraw-Hill Book Co., 330 W. 42nd St., New York* 18, *N. Y.* $4.

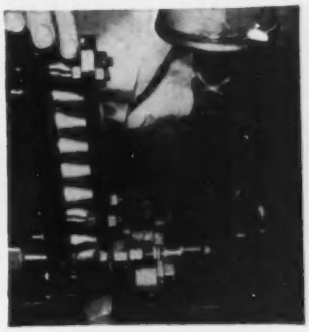
This manual explains the fundamentals of electron-tube operation and shows how it is applied in the basic circuits used in present-day industrial electronic control.

In a practical, nonmathematical treatment it covers the various types of electron tubes, fundamental circuit components, basic electronic circuits, and many complicated circuits which are typical of modern industrial practice.

In this second edition, all wiring diagrams have been redrawn to agree

For Defense or Civilian use— get the mo$t for your Zinc Die Ca$ting Dollar!

Whether for defense or essential civilian products, design ZINC Die Castings *specifically* for this metal and method of production—to achieve maximum economy. The two ZINC Die Cast fuse noses for 20 mm. ammunition pictured above were designed to give Uncle Sam the most for his dollar. The same economic considerations apply to essential civilian castings.



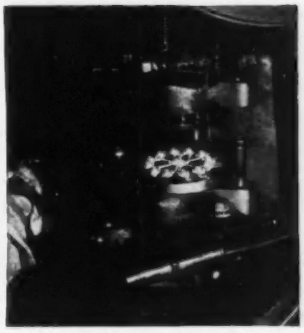
MINIMIZE MACHINING

ZINC Die Castings are often produced so close to finished dimensions that little or no machining is required. In designing the fuse noses, however, it was less costly to cut the external threads than to cast them. Since the ZINC alloy is free-cutting, this operation is performed at high speed in a lathe fitted with an automatic feeding mechanism.

For a working knowledge of the full economic possibilities of ZINC Die Castings for defense or essential civilian products, ask us—or your die caster—for a copy of "Designing For Die Casting."

UTILIZE MULTIPLE PRODUCTION

Using a die designed to produce 12 fuse noses at a time, on a "gate" which is cast at the rate of 225 to 250 per hour, over 2700 noses are produced every 60 minutes in a plunger-type die casting machine. Of the most used die casting metals, only ZINC alloys can be used in these high speed machines.



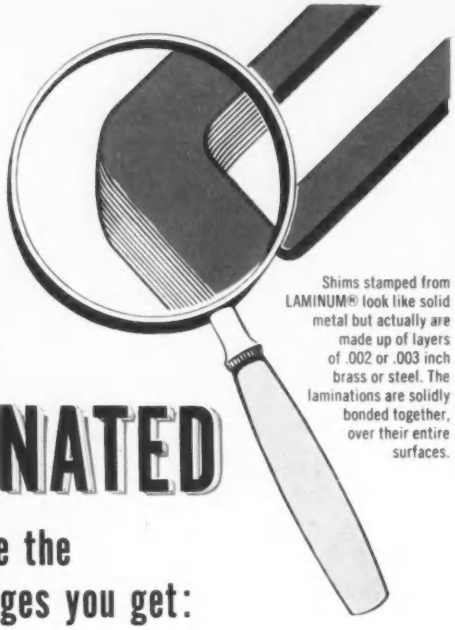
DON'T WASTE METAL

All excess metal is sheared off when the 12 castings are removed from the gate simultaneously in a punch press. Thus all of the flash metal, as well as the gate, is salvaged for remelting and reuse. This not only minimizes metal cost but conserves zinc which is so essential to the National Defense program.

ZINC
FOR DIE CASTING ALLOYS

The New Jersey Zinc Company, 160 Front St., New York 38, N. Y.

The Research was done, the Alloys were developed, and most Die Castings are based on
HORSE HEAD SPECIAL (99.99+% Uniform Quality) ZINC



Shims stamped from LAMINUM® look like solid metal but actually are made up of layers of .002 or .003 inch brass or steel. The laminations are solidly bonded together, over their entire surfaces.

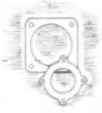
when a shim is

LAMINATED

here are the advantages you get:

REDUCED MACHINING COST

You machine only to easy tolerances. The laminated shim is *adjustable*—you simply peel laminations of .002 inch brass or steel with a penknife—to get exactly the spacing you need. You cut costs without sacrificing quality.



SIMPLIFIED USE:

Shims come to you in one "pack" for each application. They are precision-stamped to your exact specifications. No counting, no stacking, no miking. Gauge is always known. No dirt or grit can lodge between layers.

SPEEDED PRODUCTION:

Final fitting can be done right at the job. You don't have to take parts back and forth for further machining, grinding or filing. No special skill required. The laminations adjust spacing quickly, easily.

ADDED SERVICE FEATURE:

Throughout the life of the machines you produce, the simple removal of a shim lamination provides a unique adjustment for the take-up of wear. Original clearances can always be restored.

SEND TODAY for our Engineering Data File

LAMINUM

THE SOLID SHIM THAT PEELS FOR ADJUSTMENT

LAMINATED SHIM COMPANY, Inc.

1411 UNION STREET GLENBROOK, CONN.

CUSTOM SHIMS STAMPINGS SHIM STOCK

with the new ASA Industrial Electronic Symbols. Useful information on many circuits, such as counters, clamps, switches, and gates, has been included, as have typical industrial circuits in use in the field of instrumentation and motor control.

Of great value to the industrial electronic engineer will be the simple explanation of the use of electronics in closed-cycle controllers, sometimes called feedback amplifiers or servomechanisms.

Designed to give a basic working knowledge of electronic control, this guide illustrates numerous commercial circuits, helping the reader to analyze more effectively those you may be called upon to sell, install, or service. The sections covered are: Electron Tubes, Circuit Components, Basic Electronic Circuits, Closed-Cycle Control Systems, and Industrial Electronic Circuits.

Fundamentals of Electronics

F. J. MITCHELL, *Professor of Physics, University of Alabama.* 243 *pages,* 6 x 9 *in. Published by Addison-Wesley Press, Inc., Cambridge* 42, *Mass.* $4.50.

Many schools offer electronic courses directed toward two ends: First, to lay a foundation for future electronic courses for students majoring in the subject; and second, to give non-electronics majors a feeling for the adaptability of electronics in the field of measurement. This book attempts to combine these two purposes. In view of the dual function, little attempt is made at mathematical rigor. Physical reasoning, usually informal, is relied upon.

The lack of a "feel" for electric circuits is a common handicap to the appreciation of electronic devices. The only physics prerequisite that can be reasonably expected at this stage of a student's curriculum is one course in general physics. His familiarity with simple circuits, particularly transients and alternating current circuits, is likely to be sketchy. Therefore, the first two chapters dealing with circuit theory, although ostensibly a review, are usually found to be a necessary introduction to the rest of the material.

Most students entering a course of this level have some knowledge of the simpler operations of the calculus. No effort has been made to avoid its use completely. However, the results of the few sections in which it does occur can be assumed without loss of continuity. The geometric interpretation of the derivative and the definite integral is given as part of the treat-

ment of differentiating and integrating circuits in Chapter 12.

There is no pretense at completeness. The more important fundamental phenomena are covered and their applications illustrated. The stress throughout is placed on instrumentation. An eight-page folder in the back of the book is designed to facilitate the solutions of the various problems involving the graphical application of tube-characteristic curves.

Electroplating for the Metallurgist, Engineer And Chemist

J. B. MOHLER *and* H. J. SEDUSKY. 257 *pages,* 5½ x 8½ *in. Published by Chemical Publishing Co. Inc., New York,* N. Y. $5.00.

This book covers all the important aspects of practical electroplating, a knowledge of which will be of interest and value to metallurgists, engineers and chemists. It does not go into the involved details of the electrochemical theory. However, the necessary fundamentals, such as bath voltage, polarization and current distribution are discussed in simple, non-technical language. Electroplaters without scientific or engineering background should be able to use this book to advantage in trouble shooting that so often becomes necessary in this field.

The mechanism of electrodeposition, the characteristics of plating baths, the behavior of electric current during plating, the nature of the deposit, the composition of common plating baths, and control methods and analytical procedures are well covered in this book. Special chapters are devoted to alloy plating, continuous plating, diffusion coatings, copper plating for effective carburization and for commercial applications. The standard metal coatings are simply and completely described. These include copper, silver, zinc, tin, chromium, cadmium and nickel plating. The plating procedure for each type covers the formulation and preparation of the bath, its operation and control, the characteristics of the bath and preparation of the basis metal.

The most frequently encountered plating difficulties are described and discussed in a special chapter. Some of these include off-color, blistered, rough and spotty deposits, poor anode corrosion, low cathode efficiency and poor plate distribution. The causes of these troubles and measures for avoiding and correcting them are fully treated.

The operating details of common

CAN *You* USE THESE UNITS

...OR THE SKILL THAT BUILT THEM

NOTE WIDE RANGE VERSATILITY APPARENT IN LARGE AND SMALL KETTLES SHOWN

● Do your productions call for pressure kettles or processing machinery in Stainless Steel, Nickel, Monel, Everdur, Inconel? Do they require strict sanitation in the units . . . high speed heating super-efficient mixing, blending, homogenizing?

● If so, count on GROEN for competent counsel, proficient engineering, fast production. Building such units, large and small, has been our specialty for 50 years. That is why we've become today's largest producers of such equipment . . . with ample facilities, experience and financial solidarity to handle your requirements promptly and efficiently. And we're prepared to work to your roughest specifications or to create special units to solve your individual problem.

● So, if components of equipment on your Defense orders or regular production require equipment in this category, call confidently on GROEN. Write our Engineering Dept. now about your present or anticipated requirements.

TABLE TYPE VACUUM TILTING KETTLE. A typical example of GROEN engineering. Supplied as autoclave and/or equipped with various types of agitators.

200 GAL. TWIN SHAFT MIXING KETTLE. Sanitary, heavy duty type. Agitator assembly removable in a few seconds for cleaning. Twin shaft principle develops maximum mixing efficiency.

GROEN MFG. CO.
4535 W. Armitage Ave.
CHICAGO 39

30 Church Street
New York 7

7 Front Street
San Francisco 11

ILLUSTRATION SHOWS ALL AGITATOR PARTS DISASSEMBLED

WORLD'S LARGEST PRODUCERS OF

Half a Century of Fine Kettles

GROEN

STAINLESS STEEL STEAM JACKETED KETTLES

Up a Tree?

Not enough hours in your day? Here's a handy slide-chart to make your job simpler and save valuable time! This FREE chart instantly identifies A-N Nos. pertaining to stainless steel nuts, screws, bolts, rivets, cotter pins, washers; gives sizes, other data. Write for your FREE copy of Chart 51S TODAY!

Anti-Corrosive
AN STAINLESS STEEL FASTENING SELECTOR
In listing below, find AN number and note kind of fastening. Then, in proper window, set AN number and read data.
NUTS
NUMBER
NOM. SCREW SIZE
THD. PER IN.
CAT. PAGE
AN 310 C 18 1 1 8 12 22
Price and deliveries on request
See other side for RIVETS COTTER PINS WASHERS
SCREWS
NUMBER
NOM. SCREW SIZE
THD. PER IN.
CAT. PAGE
AN 501 C1 #1 72 11
Last DASH NO. indicates length in six teenths inch
AN3 to AN20 Hexagon Head, Fine Thread, Class 3 Fit Aircraft Bolts
with hole drilled in shank
C—Corrosion Resisting Steel (Stainless Steel) to Spec AN QQ S 770, Condition QT, Class II (Type 431)
H—Indicates drilled hole in head of Bolt
A—Indicates no drilled hole in shank of Bolt
Last Dash No.—Refer to drawing for length of Bolt
Number Size Thd./In. Number Size Thd./In. Number Size Thd./In.
AN3 10 32 AN7 7/16 20 AN14 7/8 14
AN4 1/4 28 AN8 1/2 20 AN16 1 14
AN5 5/16 24 AN9 9/16 18 AN18 1 1/8 12
AN6 3/8 24 AN10 5/8 18 AN20 1 1/4 12
AN12 3/4 16
AN310 Castellated Nuts, Fine Thread, Class 3 Fit
AN315 Hexagon Plain Nuts, Fine Thread, Class 3 Fit
AN316 Hexagon Double Chamfered, Double Countersunk Check Nuts, Fine Thread, Class 3 Fit
AN320 Hexagon Shear Nuts, Fine Thread, Class 3 Fit
AN340 Machine Screw Nuts, Coarse Thread, Class 2 Fit
AN345 Machine Screw Nuts, Fine Thread, Class 2 Fit
AN381 Corrosion Resisting Steel Cotter Pins to Spec FF-P-386a, Amendment 2, Type C (Type 302)
AN427 100° Flat Counter sunk Head Rivets F—Corrosion Resisting (Stainless) Steel to Spec AN-W-24, Grade G, Condition A (Type 302 or Type 304 annealed)
Coarse Thread, Class 2 Fit
Anti-Corrosive
Metal Products Co., Inc.
Manufacturers of STAINLESS STEEL FASTENINGS
CASTLETON ON HUDSON, NEW YORK

plating baths are described in the light of recent improvements. Some methods and techniques have been presented whose origin is the author's own experience in electroplating.

In the appendix are listed the various instruments and their uses in electroplating; plating tests; strike bath formulae; etching and pickling solutions; alkaline cleaning solutions and other important formulae and data. A glossary of terms used in the electroplating industry is also included.

A proper study of the fundamentals of products and processes described and discussed in this book will give the reader a good working knowledge of electroplating and will enable him to more fully comprehend its advantages and limitations.

Mathematics for Engineers

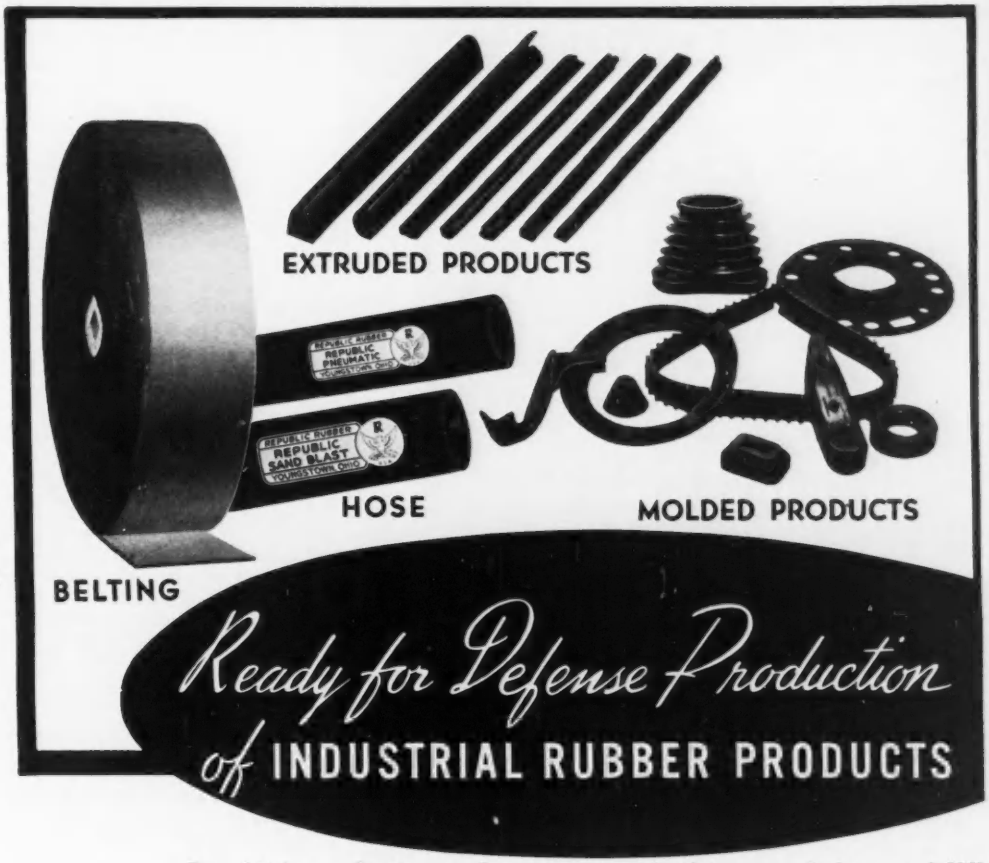
RAYMOND DULL *and* RICHARD DULL, *Webster-Chicago Corp.* 5¾ x 8¼ *in. Third Edition* 822 *pages. Published by McGraw-Hill Book Co.,* 330 *W. 42nd St., New York* 18, *New York.* $7.50.

This treatise on mathematics has been prepared primarily for engineers. Included are engineers (1) who want a quick and convenient reference, (2) who have become somewhat rusty in applying mathematics, and (3) who feel the need of a text for the study of mathematics.

The book is concise yet complete, covering every phase of mathematics the engineer is likely to meet, from algebraic notation, determinants, and linear equations—through differential calculus, curve analysis, integration summation, etc. Many graphical explanations and illustrative examples enhance the reader's understanding of the subject and enable him to successfully apply the methods set forth, in solving mathematical problems and equations in engineering.

In this revised third addition is much added material, including new chapters on Differential Equations and Dimensional Analysis, which is recognized to be an increasingly useful tool for predicting the functional form of physical relationships. The theory of geometric, kinematic and dynamic similarity and its applications to hydraulics, mechanics and vibratory systems is also included. Special emphasis is given to the Buckingham Pi theorem and its applications to the second-order differential equations of vibration.

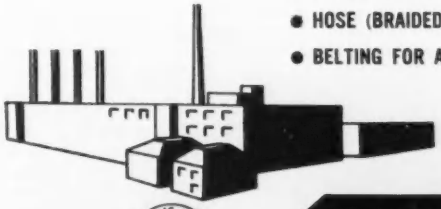
The chapter on differential equations includes detailed solutions of a few second-order forms which have



Ready for Defense Production of INDUSTRIAL RUBBER PRODUCTS

Republic's production and engineering facilities can help you fulfill defense contracts faster. . . . For 50 years we've specialized in the field of industrial rubber, making all types of:

- **MOLDED RUBBER PRODUCTS**
- **EXTRUDED RUBBER PRODUCTS**
- **LATHE OR DIE CUT SPECIALTIES**
- **HOSE (BRAIDED, WRAPPED, METAL REINFORCED)**
- **BELTING FOR ALL PURPOSES**



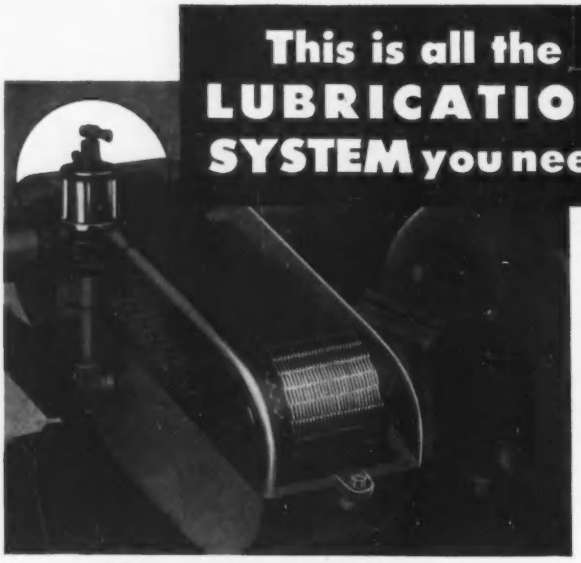
Write, phone or wire us today about your requirements. Engineering consultations are also available to help you develop bids. Address: Republic Rubber Division, Youngstown, Ohio. Phone 3-2131.

INDUSTRIAL RUBBER PRODUCTS BY

REPUBLIC RUBBER DIVISION

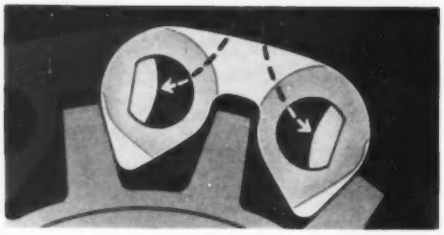
Lee Rubber & Tire Corporation

YOUNGSTOWN, OHIO



WITH **RAMSEY** SILENT CHAIN-DRIVES

Just a few drops of oil per day answers the lubrication needs of a high speed, heavy-duty Ramsey silent chain drive. A simple, inexpensive drip-feed oil cup does the job. Oil reservoirs and forced systems are not necessary. The effective *roller bearing design* of the Ramsey Chain Joint eliminates practically all friction and enables the chain to run without vibration. For smooth power and long, trouble-free life, you just can't equal a Ramsey Silent Chain drive.



Here is the reason why Ramsey is the superior silent chain. The **rolling action** of the two case-hardened pins in the joint insures quiet, smooth, friction-free operation. Note the open construction, where the oil can penetrate to the working surfaces of the pins.

GET THIS SILENT CHAIN APPLICATION MANUAL

This 60-page book gives you the range and scope of Ramsey Chain drives—tells you how to work out applications and includes the necessary data on chains, sprockets and pinions. Write for a copy today.

SILENT CHAIN DRIVES — FLEXIBLE COUPLINGS

RAMSEY
CHAIN COMPANY, INC.
5150 BROADWAY • ALBANY, N. Y.

significant physical interpretations. The chapter concludes with the exposition of a systematic numerical method used by the author for the solution of differential equations, complete with illustrative examples and computations. The utility of this method has been demonstrated by its successful application to a number of problems on gas flow and machinery dynamics.

An Introduction to Thermodynamics, The Kinetic Theory of Gases, and Statistical Mechanics

FRANCES WESTON SEARS, *Professor of Physics, Mass. Institute of Technology.* 348 *pages,* 6¼ x 9¼ *in. Published by Addison-Wesley Press, Inc., Cambridge 42, Mass.* $6.00.

In his first eight chapters, the author presents an introduction to Thermodynamics including a discussion of the first and second laws for students who equation of thermodynamics. The uses many three-dimensional sketches of P-V-T relationships to clearly illustrate changes of phase in ideal and real substances.

Chapter nine combines the first and second laws to derive the fundamental equation of thermodynamics. The Helmholtz and Gibbs functions are defined and the deviation for the Maxwell equations is outlined. The next chapter briefly discusses some engineering applications of thermodynamics. Included are the basic steam and refrigeration cycles.

Thus far, the discussion of Thermodynamic principles has been an orthodox one, i.e. properties could not be calculated quantitatively but the changes in properties for various processes could be established numerically. In most engineering problems, the answer can be obtained from the change in properties only, but to go beyond the limitations of this approach, the author introduces the kinetic Theory of Gases, Statistical Theory and Quantum Statistics.

The properties of matter in bulk are predicted, starting with a molecular theory, from two different, although related, lines of attack. The first, called the Kinetic or Dynamic Theory, applies the laws of mechanics to the individual molecules of a system, and from these laws derives expressions for the pressure of a gas, the internal energy and the specific heat capacity. The approach of statistical mechanics, which is considered to be more general, is to ignore detailed considerations of individual molecules, and to apply considerations of probability to the large number of molecules that

make up any piece of matter. It is shown that the laws governing entropy increases have a simple interpretation from the viewpoint of statistical mechanics.

Introduction to Industrial Electronics

R. RALPH BENEDICT, *Professor of Electrical Engineering, University of Wisconsin. 436 pages, 5½ x 8½ in. Published by Prentice-Hall, Inc., 70 Fifth Ave., New York, N. Y. $6.35.*

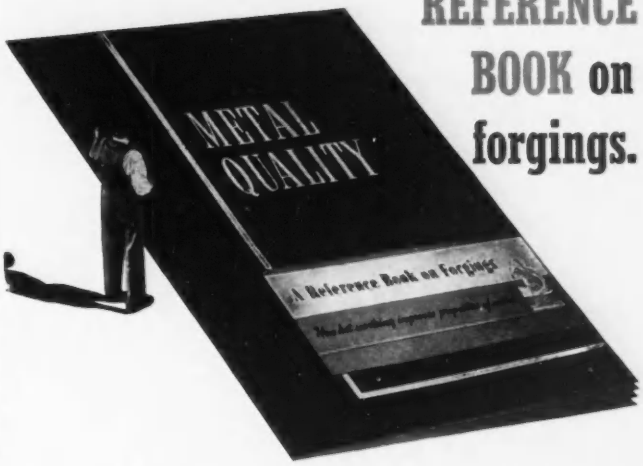
A growing interest in industrial electronics has developed, both among practicing engineers and among technical students. This is not surprising when it is realized that electron tubes serve in such diverse industrial and power applications as electronic instruments, x-ray inspection of metals, control circuits for motors and spot welders, induction and dielectric heating, and all sizes of rectifiers.

The present volume is intended to provide an introductory, but fundamental, survey of the whole subject—from a description of the basic tubes and their behavior through a treatment of elementary circuits and typical applications. More than usual emphasis is placed on gaseous tubes, phototubes, and the cathode-ray oscilloscope because of their importance in the industrial field. Amplifiers, oscillators, detectors, and modulators have been treated in a rather brief, qualitative fashion. The remainder of the book deals with circuits and electronic systems useful in the industrial and power fields. These applications have been chosen to illustrate fundamental principles, though, in general, the principles are introduced gradually in connection with the applications so as to maintain the interest of the reader.

This text makes use of approximate methods of calculation and graphical analysis where feasible, and thus avoids the use of the advanced mathematical methods that are needed for the exact analysis of the non-linear relations associated with electron tubes. Some elementary calculus is employed, and the reader is assumed to have an elementary knowledge of direct-current circuits and apparatus and of alternating-current circuits. A few articles introduce simple differential equations, but these may be omitted if desired.

The industrial fields, of course, use much less electronic components than the communications field. Yet, the amount is increasing so special rugged-ized parts are being developed for industry.

What *Forgings* have that offer so many more economic, engineering and production advantages than can be obtained with any other material, is illustrated and described in this REFERENCE BOOK on forgings.

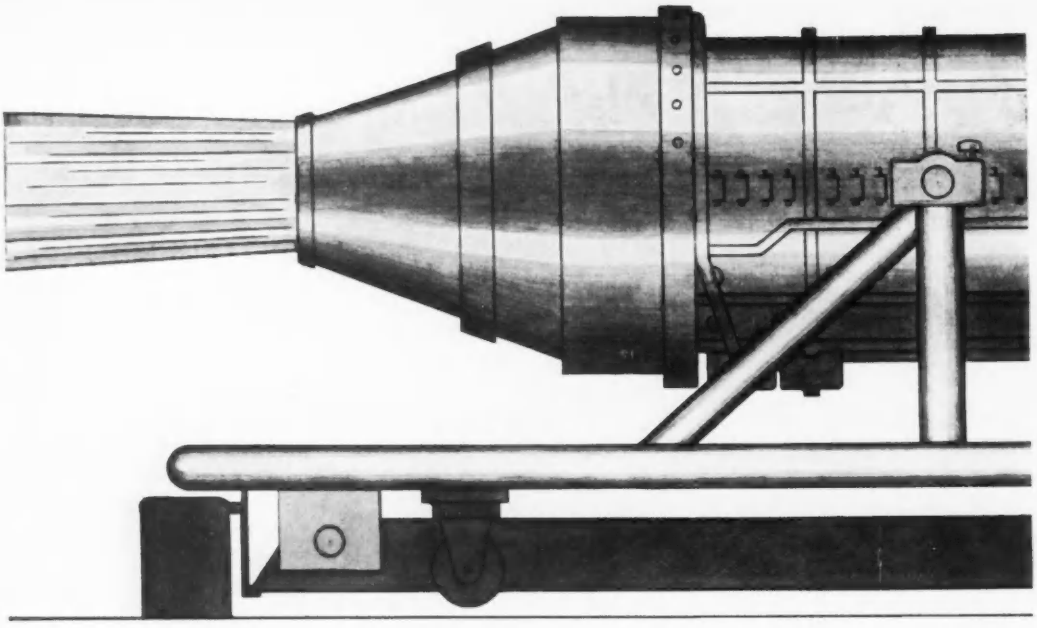


Write for a copy. Then consult a forging engineer about how you can obtain the correct combination of mechanical qualities in forgings for your particular type of equipment.

DROP FORGING ASSOCIATION
605 HANNA BUILDING
CLEVELAND 15, OHIO

Please send 60-page booklet entitled "Metal Quality—How Hot Working Improves Properties of Metal", 1949 Edition.

Name.....
Position.....
Company.....
Address.....



New Applications of the
SR-4® LOAD CELL
Bring Higher Precision in
JET THRUST
with the
BALDWIN
THRUST STAND

The thousands of pounds of thrust needed to project a jet plane through sonic barriers can now be measured with highest accuracy and exact reproductability on the new Baldwin Jet Engine Test Stands at Wright Aeronautical Corporation.

Basic design was worked out in close cooperation with Wright Aeronautical Corporation to eliminate hazards and inaccuracies.

No pit or ramp is required. This makes it unnecessary to install costly air and water scavenging systems to remove combustible vapors. It also eliminates the use of lift trucks in the test cell.

The engine is easily moved and positioned. The engine dolly is wheeled over the thrust stand. Base structure guides it into position.

The mounting imposes no questionable restraint on the weighing system. Air-actuated tapered retractable pins engage with tapered bores, lifting dolly wheels from the floor, and firmly integrating dolly and thrust table.

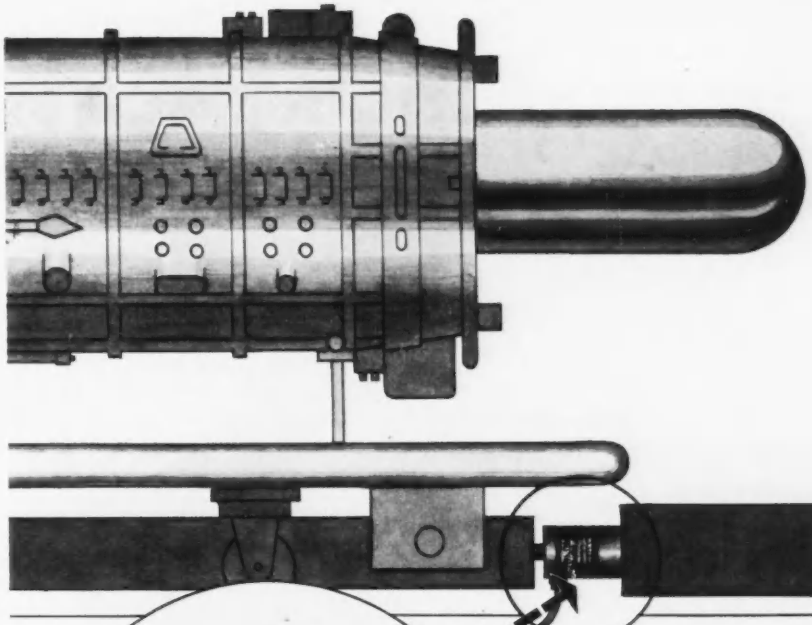
Safety interlocks prevent accidents. Fuel cannot be supplied until retractable pins are fully engaged.

Maximum accessibility is preserved. Access is limited only by the dolly structure itself.

Top precision in measurement is attained. The Baldwin SR-4® Load Cell accurately transmits forces to the remote indicating instrument. Frictional and other unmeasurable losses are greatly reduced. The restraint exercised by the four stay-plates can be calibrated out of the indicating instrument.

TESTING
BALDWIN-LIMA

Eddystone Division, Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.



BALDWIN SR-4® LOAD CELL

The Heart of the Weighing System

The Baldwin Type "U-1" SR-4® Load Cell is a sensitive, accurate device that translates changes in weight into proportional changes in electrical energy. Ruggedly constructed, hermetically sealed, and with no moving parts, it employs the well-known SR-4® strain gage as a pickup. The gage is mounted on a rectangular steel column. Deformation of this column under load is accurately calibrated.

External circuits are entirely electrical. Recording, indicating or monitoring instruments and controls can be located at any remote point. This is but one of dozens of current applications for this load cell . . . and its possibilities have not yet been explored.

Baldwin currently offers the most complete line of testing equipment available. This line is constantly expanded to meet new needs. In addition, Baldwin is always ready to work with you in developing special equipment to solve special problems. Your inquiries are welcome.

HEADQUARTERS

-HAMILTON

In Canada: Peacock Bros., Ltd., Montreal, Quebec

Want a tubing that's a bear for punishment? Look into Bundyweld!

Bundyweld Tubing is double-walled from a single strip. Exclusive, patented beveled edge affords smoother joint, absence of bead, less chance for any leakage.

Here's the best-known small-diameter tubing of them all.

It's Bundyweld, preferred in industry and defense wherever tubing parts must ride rough herd through vibration, stress, shock or strain. The reason is simple . . . and exclusive. Bundyweld, the multiple-walled type of Bundy® tubing is double-rolled from a single strip with inside beveled edge. No other like it anywhere.

For information on availability, for help in design or fabrication of any tubing part, why not come to headquarters for small-diameter tubing today?

Bundy Tubing Company

DETROIT 14, MICHIGAN

World's largest producer of small-diameter tubing

AFFILIATED PLANTS IN ENGLAND, FRANCE AND GERMANY

The problem was...

How to get extra copies of blueprints—

fast!

A case history based on the experience of the American Brake Shoe Company, Kellogg Division, Rochester, N. Y.

The blueprints (and direct-process prints) submitted by customers placing machining orders used to be a problem for the Kellogg Division, American Brake Shoe Company.

Invariably, prompt delivery was requested. But... before production could begin, extra copies of each customer-print were needed. Being semi-opaque, these prints could not be used as print-making masters in Kellogg's direct-process machine. How, then, could the extra copies be obtained in the shortest time... and at the lowest cost?

Kodagraph Autopositive Paper was the answer

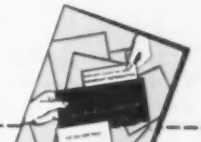
Now... extra copies are made quickly... economically

With Kodagraph Autopositive Paper, Kellogg reproduces the blueprints, direct-process prints, and other types of "originals" *directly*... quickly obtains the print-making masters that are needed so urgently.

The operation is simple... is performed under ordinary room light. Autopositive Paper is exposed in contact with the customer's print in Kellogg's direct-process machine. It is then processed in standard photographic solutions. The result is a sparkling, long-lasting, highly legible photographic reproduction—dense blacks, clean whites—on a durable, evenly translucent paper base. From this Autopositive intermediate, the required number of extra copies can be turned out... at practical, uniform machine speeds.

Kodagraph Autopositive Paper

"THE BIG NEW PLUS" in engineering drawing reproduction



- **It enables you, or your blueprinter, to produce photographic intermediates directly, at a new low cost, without an extra step.**
- **It enables you to protect valuable originals from wear and tear.**
- **It gives you photo-lasting file copies.**
- **It restores old, worn drawings ... reproduces opaques.**

MAIL COUPON FOR FREE BOOKLET

EASTMAN KODAK COMPANY
Industrial Photographic Division, Rochester 4, N. Y.

Gentlemen: Please send me a copy of your illustrated booklet giving all the facts on Kodagraph Autopositive Paper. 15

Name _____ Position _____
(please print)

Company _____

Street _____

City _____ Zone _____ State _____

Kodak
TRADE-MARK

Losing time on friction problems?

Let your J-M friction specialist speed your solution

YOUR FRICTION PROBLEMS need never be time-wasters when Johns-Manville industrial friction specialists are just waiting for a phone call or letter from you.

These experts will help you select the *right* friction material to solve your special problems quickly.

How can Johns-Manville give you this "Johnny-on-the-spot" service? Here's the story:

1. **We are pioneers** in the manufacture of friction materials for every type of equipment.
2. **We have built** up a storehouse of "know-how" by our contacts in supplying these materials to practically every type of industry.
3. **We maintain** one of the most extensively equipped laboratories in the world for the development of friction materials.

So regardless of your friction problem, don't lose time. Instead, phone or write your nearest Johns-Manville office—or write Johns-Manville, Box 290, New York 16, New York—and a J-M friction specialist will be on his way to help solve it in a hurry.

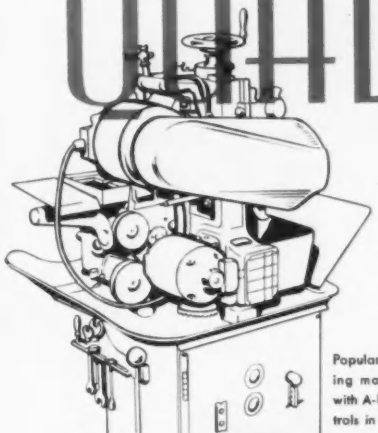
Here's your guide to the right friction material for the job—

Booklet FM-12A (right) is yours for the asking. It contains complete descriptions, specifications, and a handy selector chart. For your copy write Johns-Manville, Box 290, N. Y. 16, N. Y.

JOHNS MANVILLE JM PRODUCTS

Johns-Manville *Asbestos* FRICTION MATERIALS

QUALITY CONTROL COMPONENTS



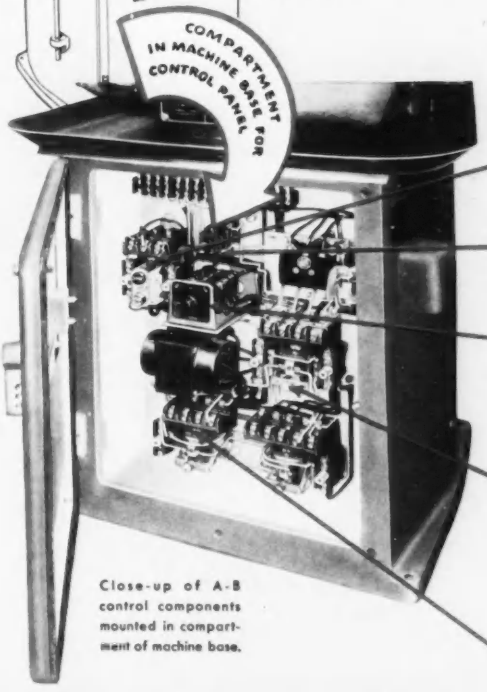
Popular milling machine with A-B controls in base.

If you design or manufacture motorized machinery, it will pay you to consider A-B controls.

These time-tested A-B control components are available in a wide variety of types and sizes. With these components, quickly selected from the A-B Handy Catalog, you can assemble control panels to provide the exact control sequence needed for maximum output.

If you have a new machine on your drawing boards, why not call in an Allen-Bradley control engineer. His advice may simplify your control design and improve your machine operation.

Allen-Bradley Controls are a Sales Asset to any Machine Tool



Close-up of A-B control components mounted in compartment of machine base.

MANUAL STARTERS
Bulletin 609 Manual Starters have quick make, quick break contacts and overload relays. In a variety of enclosures.

SELECTOR SWITCHES
Selector switches and oiltight push buttons.

DRUM SWITCHES
Drum Switches for pilot control service, reversing operation, and multi-speed motor control. Furnished in enclosures.

COMBINATION STARTERS WITH DISCONNECT UNITS
These Bulletin 712 Combination Starters have a manually operated disconnect unit and a magnetic starter switch with overload relays on a single mounting plate. Can also be furnished with circuit breaker.

MAGNETIC SWITCH
The A-B line of Bulletin 709 Solenoid Starters are available in 7 sizes, 1 to 300 hp, 220 v; 600 hp, 440-550 v. All have double break, silver alloy contacts and overload relays.

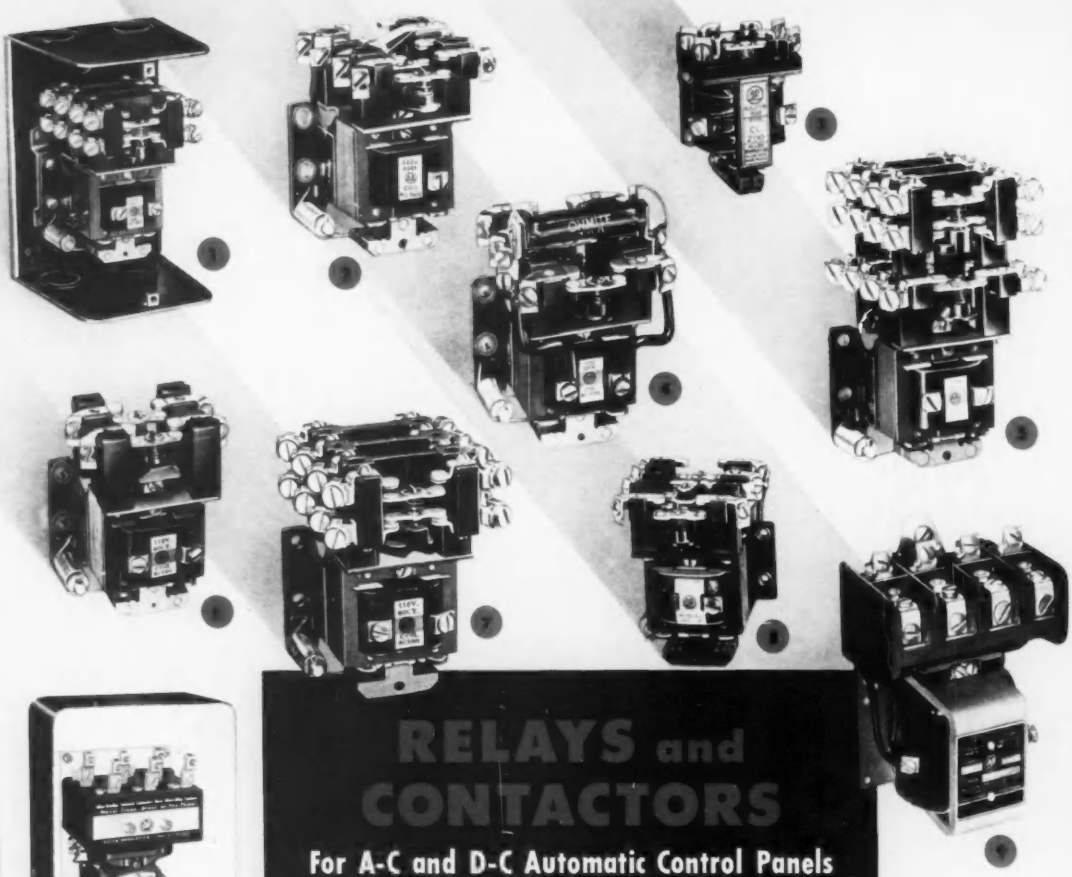
851-R

Follow the example of leading machine tool manufacturers by adding A-B controls as a sales asset to your motorized machines. Catalog will be gladly sent to you on request.
Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wisconsin

ALLEN-BRADLEY

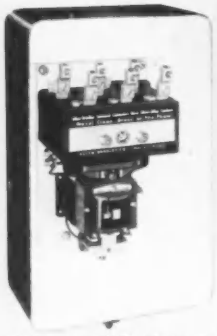
MOTOR CONTROL

A-B Quality

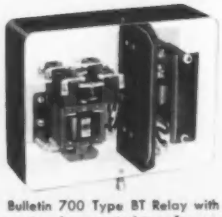


RELAYS and CONTACTORS

For A-C and D-C Automatic Control Panels



Fifty ampere 3-Pole Contactor in a general purpose Type 1 Enclosure.



Bulletin 700 Type BT Relay with a step-down control transformer.

Do you need small relays from one to 8 poles . . . or contactors up to 900 amperes? Do you want hum-free contactors? You will find all of these units, and more, too, in the Allen-Bradley line . . . factory tested . . . ready to install . . . and good for millions of maintenance-free operations.

Type BX universal relays have interchangeable normally open and normally closed contacts. No reassembling needed to change contacts.

A few of the many relays in the Allen-Bradley line are illustrated above.

- Type BX Universal A-C Relay—in Enclosure
- Type BM Mechanically Held Relay—No Hum
- Type CL Low Coil Current Relay
- Type BA 3-Wire Thermostat Relay—Open
- Type BX 8-Pole Universal Relay—Open
- Type B 2-Pole A-C Relay—Open
- Type BX Universal A-C Relay—Open
- Type BM Mechanically Held Relay—Open
- Bulletin 202 2-Pole D-C 25-Ampere Relay

Write for Bulletins 700 and 200.

Allen-Bradley Co., 1316 South Second Street, Milwaukee 4, Wisconsin

ALLEN-BRADLEY

MOTOR CONTROL

QUALITY

A-B Quality

851-R

Automatic Molding cuts costs for Electric Steam Radiator

These fully automatic molding presses have operated 24 hours a day ever since they were installed. The only work required is filling hoppers and removing finished parts.

New production figures of the Electresteem vaporizer and the Baby Chef Jr. bottle warmer are gratifying to both executive and shop levels of Electric Steam Radiator Corporation, Paris, Ky.

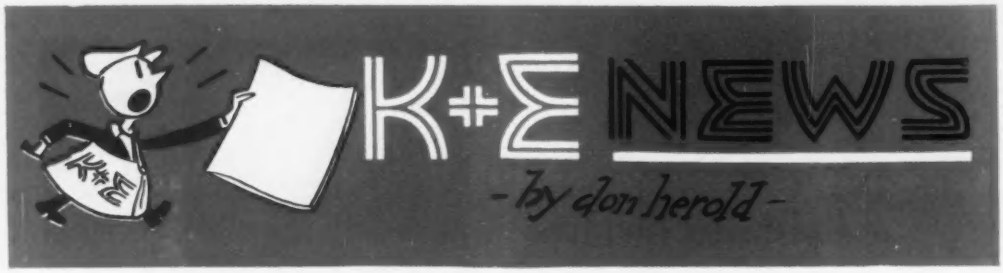
In the re-designed form—plastics replacing porcelain—the product is generally superior: more durable, lighter, easier to handle, and with less external heat loss.

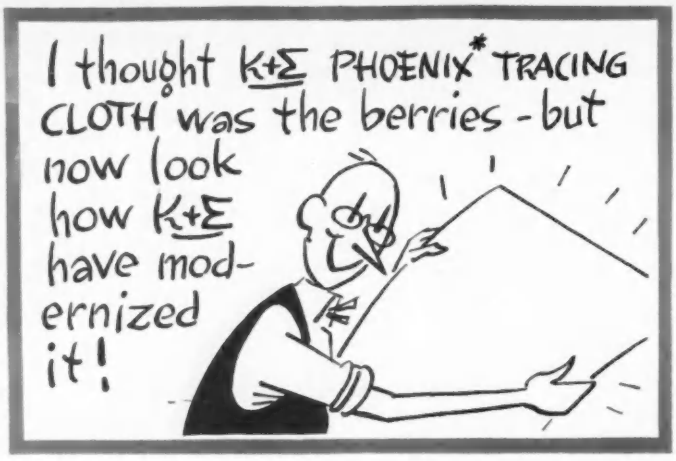
If you want to know what automatic molding can save you in production costs, send parts or blueprints for a free analysis and report by Stokes engineers.

STOKES MAKES Automatic and Semi-Automatic Molding Presses, Plunger Presses, Closure Presses, Preforming Presses, Industrial Tabletting and Powder Metal Presses, Vacuum and Special Processing Equipment, Water Stills and Special Machinery.

STOKES

F. J. STOKES MACHINE COMPANY, 5900 TABOR ROAD, PHILADELPHIA 20, PA.





how good can a tracing cloth get!

PHOENIX* Tracing Cloth always did feel good to an engineer's pencil, but, now, new improved N166 PHOENIX feels better than ever—performs better—is better. It's whiter than ever—which gives it better contrast for pencil line drawings. (This helps reprint transparency.)

The new PHOENIX is toughened to take today's new vigorous printing techniques—repeated trips under higher powered lights or through hotter printing machines.

The new N166 thrives under an ultra-violet test, which equals thousands of prints on a machine, or years of exposure to daylight. No appreciable yellowing.

Improved PHOENIX resists heat of glass cylinders even as high as 250° to 275°. Will not stick.

K&E have also given this cloth a Bureau of Standards three day 212° heat test, which is the equivalent of years of aging. It retains its whiteness remarkably well.

The new PHOENIX resists ammonia vapors and discoloration by contact with diazo prints in storage.

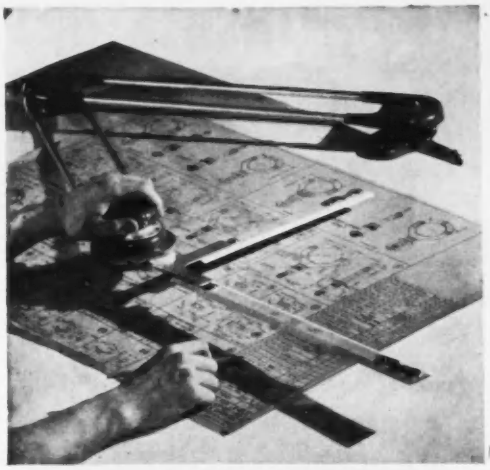
Its surface takes friction heat of motor erasers without softening or stain.

2-way water resistant

Both sides of the new PHOENIX are wonderfully water-resistant. This is important, since, if one side is more water-resistant than the other, the weaker side runs the show. By water, I mean water AND perspiration.

Gosh, I never dreamed I could say so many exciting things about a piece of cloth!

*Trade Mark Ⓡ

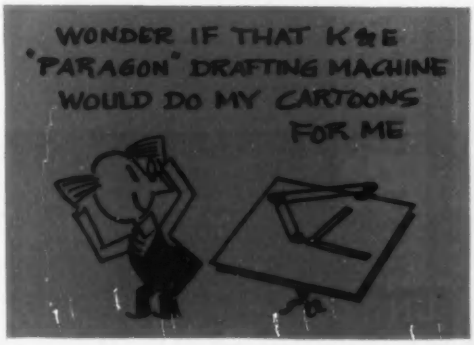


it's twice as fast as "human" drawing

You wouldn't try to be Rachmaninoff without a piano, or a Kreisler without a fiddle. Well, who would want to be a draftsman without a K&E PARAGON† DRAFTING MACHINE?

This miracle machine makes you a veritable orchestra leader at your drawing board. It combines T-squares, triangles, protractors and scales, all in one unit, controlled entirely by one hand.

You can move a rule all over the board, and the rule stays parallel to its original position. You can draw all lines to exact length. The lightest touch rotates the scales to any angle desired.



Permanent accuracy is assured, because the open center arm construction makes it practically impossible to disturb the factory-set band tension.

†Trade Mark

this whee-e-eraser saves time and elbow grease

This K&E MOTORASER* makes old-fashioned hand erasing look horse and buggy. It reduces your erasing time to seconds.

Since it depends on speed rather than pressure, the MOTORASER does not wear holes in paper. It's as accurate as a pencil point, yet will clean large areas in a jiffy.

It's handy in the hand—a 3 inch palm full with a finger-tip switch—only 6 oz. Uses AC juice —60 cycle 110 volt AC—or DC with an inexpensive adapter. A sturdy little feller, too.

*Trade Mark

For further information about any of the above products, ask a K&E Distributor or any K&E Branch, or write to Keuffel & Esser Co., Hoboken, N. J.

K&E
partners in creating
For 83 years K&E equipment and materials have been partners of the draftsman, engineer and scientist in shaping the modern world.

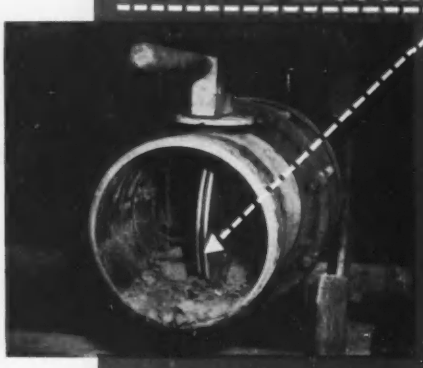
KEUFFEL & ESSER CO.

Drafting, Reproduction, Surveying Equipment and Materials, Slide Rules, Measuring Tapes

NEW YORK • HOBOKEN, N. J.
CHICAGO • ST. LOUIS • DETROIT • SAN FRANCISCO
LOS ANGELES • MONTREAL

IN THE *TOUGHEST* SERVICE...

POSITIVE CLOSURE



and easy repairs with

LINEAR "O" RINGS

Working conditions under which valves must operate in rotary drilling mud systems *really* are tough! Shale settling on the seat of gate valves prevents perfect closure. And valve wear is rapid; repairs frequent.

These troubles are eliminated by Mudco Butterfly Valves with Linear "O" Ring fitted disk!

The wiping action of the "O" Ring during closure permits the disk to close tightly in spite of accumulated shale and debris in the line. *And, the higher the pressure, the tighter the seal!*

When replacement is finally necessary, the valve is renewed simply by replacing the "O" Ring. The job is done *in the field* without costly machine-shop repairs.

Linear "O" Rings are compounded of natural or synthetic rubber, fluorethylene polymers, and "Silastics" . . . are molded in a complete range of J.I.C. and A.N. standard sizes, as well as hundreds of non-standard sizes and special shapes. Precision molded under rigid laboratory control, Linear "O" Rings may be depended upon for continuous and lasting service.

It will pay you to consult Linear during the design stages of your sealing applications.

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILADELPHIA 35, PA.

PORCELAIN INSULATORS THAT FIT YOUR NEEDS

This insulator half ring is an excellent example of Universal's ability to design and manufacture ceramic insulators to fit specific needs. In addition, it provides every quality of fine porcelain — uniform density of body, high dielectric factor, resistance to temperature extremes, physical shock, fumes, moisture, corrosion, smoke and acids. For insulators to fit your requirements, consult with Universal. An experienced engineer will be glad to assist you.

THE UNIVERSAL CLAY PRODUCTS CO.
1545 EAST FIRST STREET U SANDUSKY, OHIO
TRADE MARK

NEW...

Extremely sensitive
PRESSURE & VACUUM
Switches

TYPE SB

The new Type SB pressure and vacuum switches are for use in applications in which close on-off differentials and absolutely consistent maintenance of cut-in and cut-out settings are essential in the control of pressure or vacuum. Available are two pressure models and two vacuum models. The Pressure Switches have adjustable ranges from 0-15 psi and adjustable on-off differential from .1" wc-10" wc. They may be furnished as calibrated, micrometer type or uncalibrated for screw driver adjustment.

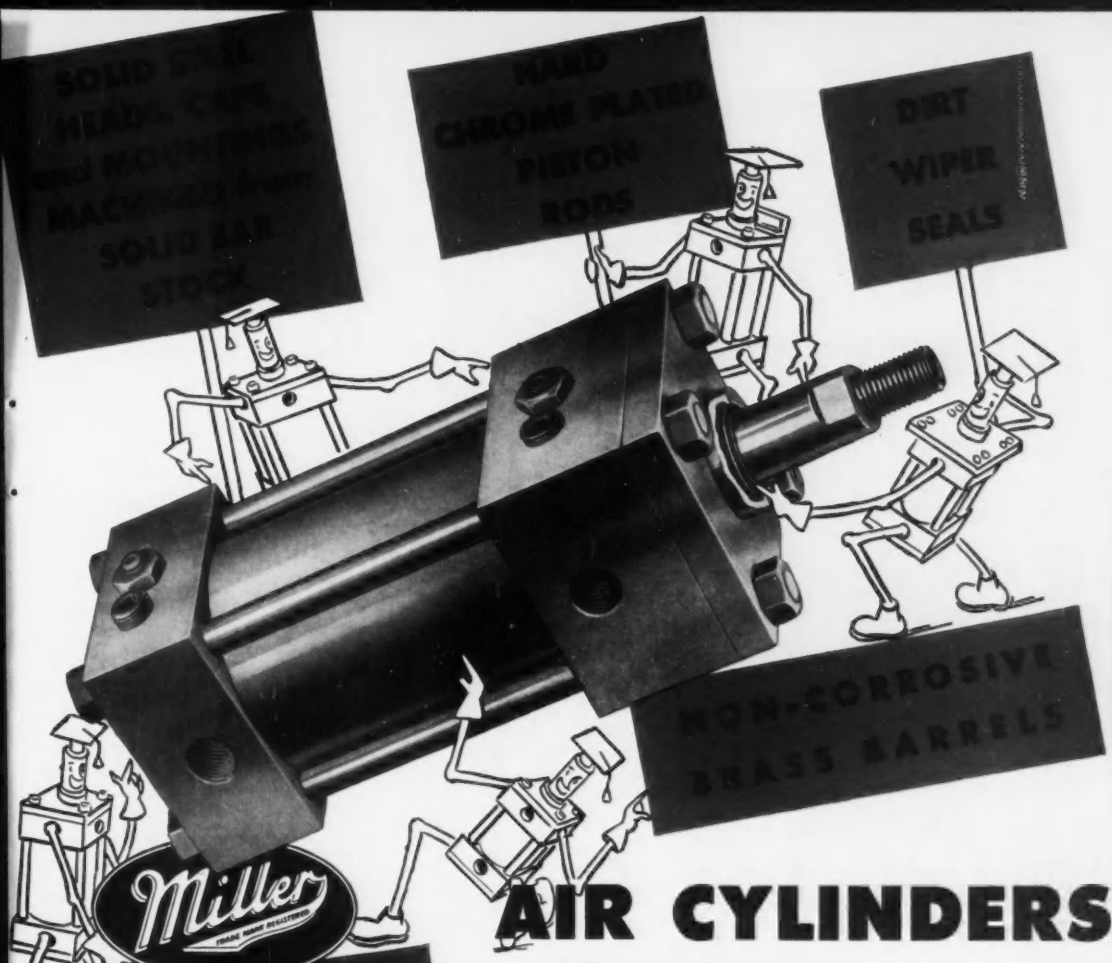
Electrical ratings at 125/250 V AC between 1200 watts and pilot duty depending on differential. The Vacuum Switches offer adjustable ranges from 30"-0" hg vac with adjustable on-off differential from .1" wc-10" wc. Furnished as calibrated micrometer type or uncalibrated with screw driver adjustment. Electrical ratings of both models 1200 watts at 125/250 V AC.

UNITED ELECTRIC CONTROLS COMPANY
81 School Street
Watertown, Mass.

Special models available for requirements not included in the specifications above.

Write for new bulletin 4926 P giving complete details today.

STANDARD & SPECIAL THERMOSTATS & PRESSURE SWITCHES



AIR CYLINDERS

Meet J.I.C. PNEUMATIC STANDARDS . . .

(Write for FREE copy of these "Standards")

The four features illustrated above serve to show how Miller Air Cylinders *for years* have been meeting— *even exceeding*—the high quality set by the recently adopted J.I.C. Pneumatic Standards for Industrial Equipment. See for yourself! . . . Write for our free bulletin A-105 and receive also your own *free* personal unabridged copy of these "Standards" with standard symbols, sample circuit, interesting point-by-point comparison—all neatly compiled into a handy booklet that fits your reference file and folds to fit your pocket.

COMPLETE MILLER CYLINDER LINE INCLUDES: AIR CYLINDERS, 1½" to 20" BORES, 200 PSI OPERATION; LOW PRESSURE HYDRAULIC CYLINDERS, 1½" TO 6" BORES FOR 500 PSI OPERATION, 8" TO 14" BORES FOR 250 PSI; HIGH PRESSURE HYDRAULIC CYLINDERS, 1½" TO 12" BORES, 2000-3000 PSI OPERATION. ALL MOUNTING STYLES AVAILABLE.

Miller

MILLER MOTOR COMPANY

2002-04 N. HAWTHORNE, MELROSE PARK, ILL.

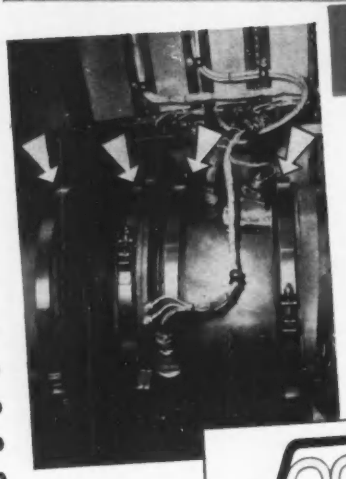
AIR AND HYDRAULIC CYLINDERS · ACCUMULATORS · COUNTERBALANCE CYLINDERS · BOOSTERS · AIR HOISTS

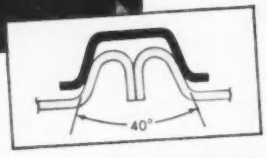
CLEVELAND — PITTSBURGH — PHILADELPHIA — DETROIT — YOUNGSTOWN — BOSTON, HARTFORD — NEW YORK CITY — DAYTON — ST. PAUL — FORT WAYNE — INDIANAPOLIS MILWAUKEE — NASHVILLE — SEATTLE — LOS ANGELES — SAN FRANCISCO — BALTIMORE ST. LOUIS and OTHER AREAS.

Sales and Service from coast to coast

ENGINEERS' NOTEBOOK

HEATING SYSTEMS





V-BAND COUPLINGS

simplify assembly and maintenance

Marman V-Band Couplings connect iris valve and expansion joints of the Douglas C-124 Globemaster II anti-icing and cabin heater. They withstand a temperature range of -65°F to 450°F with an operating pressure of 2.5 p.s.i. Marman sheet metal flanges welded to the ducts provide a quick, economical seal and the quick coupler feature of the coupling latch speeds assembly and disassembly.

Save Cost, Time and Weight with Marman

FOR INFORMATION, WRITE DEPT. E-11

10 3-410

MARMAN PRODUCTS CO. INC.

940 WEST FLORENCE AVENUE
INGLEWOOD, CALIFORNIA

STANDARD CLAMPS FOR SPECIAL APPLICATIONS

ENGINEERS
DESIGNERS
PHYSICISTS

The Aerophysics & Atomic Energy Research Division of North American Aviation, Inc. offers unparalleled opportunities in Research, Development, Design and Test work in the fields of Long Range Guided Missiles, Automatic Flight and Fire Control Equipment and Atomic Energy. Well-qualified engineers, designers and physicists urgently needed for all phases of work in

Supersonic Aerodynamics
Preliminary Design & Analysis
Electronics
Electro-Mechanical Devices
Instrumentation
Flight Test
Navigation Equipment
Controls
Servos
Rocket Motors
Propulsion Systems
Thermodynamics
Airframe Design
Stress & Structures

●

Salaries Commensurate with training and experience

Excellent working conditions. Finest facilities and equipment

Outstanding opportunities for advancement.

Write now—Give complete resume of education, background and experience

●

Personnel Dept.
Aerophysics & Atomic Energy Research Division

North American Aviation
INC.
12214 LAKEWOOD BLVD.
DOWNEY, CALIFORNIA

KOPPERS POLYSTYRENE joins the Medical Corps!

THE demand for certain types of medical equipment sent product engineers into their laboratories, and again they found another use for Koppers Polystyrene. They developed an all-plastic blood and plasma infusion set with a heart of Koppers Polystyrene. The filter housing for the woven nylon filter drip-meter is a rigid, transparent, completely sealed tube of polystyrene which has higher resistance to breakage than glass. Polystyrene needle adapters, at the ends of vinyl tubing, provide a tight, secure fit to the needle, and permit visual evidence of blood flow. The unit is sterilized before shipment and is discarded after use. These all-plastic, low-cost infusion sets are ideal for use in military field emergencies, receiving stations and base hospitals as well as in normal hospital applications.

Koppers Polystyrene 81 was used in these sets because its high heat resistance and easy moldability resulted in a faster molding cycle, and produced a light weight unit with a high resistance to breakage.

Technical data on the molding characteristics of Koppers Polystyrenes are available upon request. As always, we want to work with you to obtain the best results from your use of Polystyrene . . . to solve your particular molding problems (with special attention to military end uses) . . . and to design new products to be made from Koppers Polystyrene when the supply situation again becomes normal.

Saftiset* and Saftifilter* are molded by Modern Plastics Co., Los Angeles, California, for Cutter Laboratories, Berkeley, California.

*Cutter Laboratories Trade Name

Koppers Polystyrene has made Many Products Better and Many Better Products Possible.

KOPPERS

Koppers Plastics

KOPPERS COMPANY, INC., Chemical Division, PITTSBURGH 19, PA.

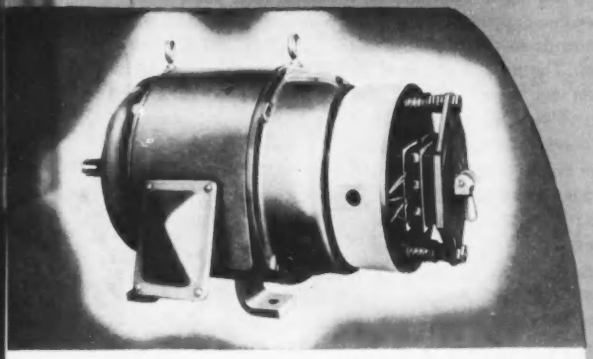
SALES OFFICES: NEW YORK · BOSTON · PHILADELPHIA · CHICAGO · DETROIT · LOS ANGELES

NEW!

DINGS DIRECT ACTING DISC-TYPE MAGNETIC BRAKES—AC OR DC

with these new design features:

- SIMPLE • COMPACT • NO SOLENOIDS
- NO MECHANICAL LINKAGES • HIGHEST THERMAL RATINGS
- INSTANT, SMOOTH OPERATION • EXTRA SAFETY FEATURES



Above: Shown with cover removed. Note how adjustment can be made with complete safety.

Below: The entire unit, disassembled. Few parts, simplicity keep maintenance negligible, assure long life.

● THE new Dings Disc Type Magnetic Brake is designed to stop any motor smoothly and instantly, to hold the load with absolute dependability and to release with no drag. Typical applications: machine tools, hoists, cranes, elevators, screwdowns, etc., and a variety of other applications where automatic, controlled braking is required. Dings Brakes are spring engaged and magnetically released and are designed to mount on NEMA TYPE C motor flanges.

FEATURES AND ADVANTAGES

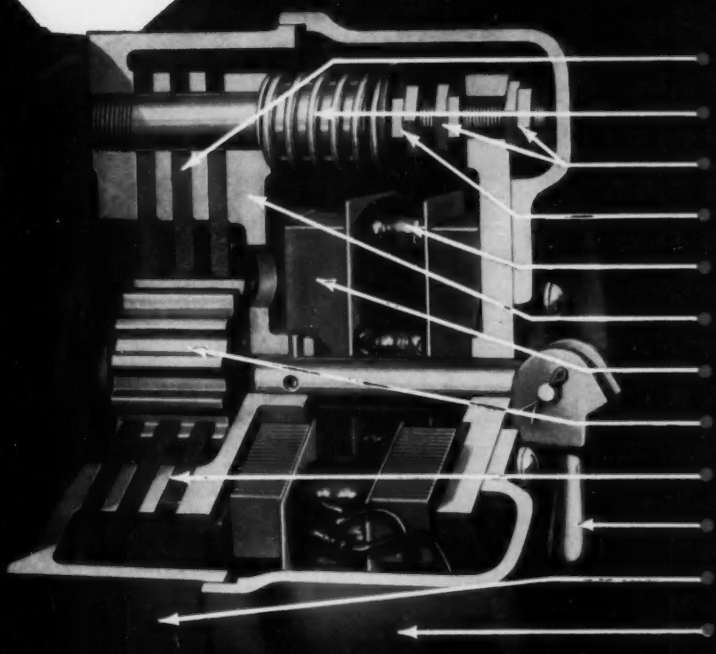
SIMPLE, COMPACT. There are *no solenoids, no mechanical linkages.* Friction disc, pressure plate, springs and magnet constitute the heart of the unit. (See photo at lower left.)

HIGHEST THERMAL RATINGS. *New* highs in thermal ratings have been obtained in the Dings Brake. Catalog B-4000-A contains exact ratings.

INSTANT OPERATION. Movement of braking assembly is measured in thousandths of an inch. Braking or releasing is therefore virtually instantaneous.

EASY INSTALLATION. Brake mounts in a few minutes. *Dismantling before installing is not necessary.*

EASY ADJUSTMENT. Torque and wear adjustment is



made by a twist of the wrench on a set of double lock nuts. Visual inspection of position of manual release lever is all that is needed to check for wear.

MANUAL RELEASE. A manual release lever, located outside the housing, is standard. Use of lever enables operator to disengage brake, allows shaft free rotation when desired. This mechanism automatically resets itself, restores unit to usual operating condition when power is again applied.

SAFETY FEATURES: In adjusting, it is impossible for operator to increase torque beyond ability of magnet to release. In addition, the shell of the housing shrouds the rotating discs, enabling the operator to make inspection and adjustment with complete safety while unit is in operation.

It's new. It's different. It's the *combination* of advantages that make this new brake worth looking into.

SEND FOR BRAKE BULLETIN

gives complete torque ratings, thermal ratings, dimensions . . . describes principle of operation, construction, installation. Everyone concerned with brakes should have a copy.

DINGS BRAKES, INC.

4740 WEST ELECTRIC AVENUE • MILWAUKEE 46, WISCONSIN

A Subsidiary of: DINGS MAGNETIC SEPARATOR COMPANY

EXCLUSIVE BUILDERS OF MAGNETIC SEPARATORS, LIFTING MAGNETS AND MAGNETIC SPECIALTIES

Fast, economical production of your special design formed and threaded parts by Cleveland's cold extrusion methods

This may be a *better way* for you to procure those special integral parts that your engineers have designed. It pays you to search for a means to produce a *stronger* part, make it *faster,* or to *lower its cost.* Making it by our Kaufman Process—by single or double extrusion—may be the answer to one or all of these factors. Send blue prints and specifications. We'll tell you what we can do about it.

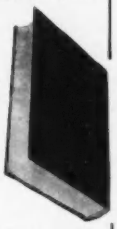
THE CLEVELAND CAP SCREW COMPANY
2917 East 79th Street, Cleveland 4, Ohio

CLEVELAND *Top Quality* FASTENERS

THE ART OF COLOR AND DESIGN

2nd Edition Just Out!

Develop improved judgment and skill in design, in both color and black and white. This well-known guide tells how to use line, direction, shape, size, texture, value, and color, to get artistic compositions that have unity, conflict, and dominance. Explains new knowledge of color and shows how to arrive at perfect color combinations. New edition gives enlarged Graves Design Judgment Test, a new Taste Test, and 150 new illustrations. **By Maitland Graves, Pratt Inst. 2nd Edition, 439 pp., 379 illus., 36 charts, 12 color plates. $6.00**



Just Out!

ENGINEERING GRAPHICS

Extends the treatment of engineering drawing to "engineering graphics," providing methods of attacking problems that are in many cases quicker and more accurate than algebra. Fully covers techniques and applications of engineering graphics, including how to determine when to use this rather than an algebraic approach to a specific problem. **By John T. Rule, Head of Dept. of Graphics and Curricula, G'nl Science and Eng. M.I.T., and Earle F. Watts. 298 pages, 422 illus., $3.75**

INDUSTRIAL PRODUCTION ILLUSTRATION

Covers the entire range of pictorial drawing, providing the necessary instructional material for production illustration in aircraft, shipyard, or ordnance fields, and for illustration in the servicing and maintenance fields of any machine or automotive industry. Discusses both freehand and instrumental layouts; covers isometric, dimetric, and trimetric drawing; and gives an original method of making axonometrics. **By Randolph Philip Hoelscher and Clifford Harry Springer, both of the University of Illinois, and Major Richard F. Pohle, Third Edition, 213 pp., 8½ x 11, 296 illus. $5.75**

DICTIONARY OF COLOR

A practical aid for the selection, identification and precise matching of colors, presenting 7,690 colors, together with 2,590 accepted color names. You can use it in communicating precise color specifications in recording colors in manufactured end products; color coding of merchandise—in establishing a basis for tolerance in color specification—in identifying and recording just perceptible color differences in scientific research, etc. **By A. Maerz, Dir. American Color Res. Laboratory, and M. Rea Paul, Consultant, Munsell Color Clinic. Second Edition, 208 pages, $25.00**

SEE THESE BOOKS 10 DAYS FREE

McGraw-Hill Book Co., 330 W. 42nd St., NYC 18
Send me book(s) checked below for 10 days' examination on approval. In 10 days I will remit for book(s) I keep, plus few cents for delivery, and return unwanted book(s) postpaid. (We pay for delivery if you remit with this coupon; same return privilege.)

- ☐ Graves—Color and Design—$6.00
- ☐ Rule & Watts—Engineering Graphics—$3.75
- ☐ Hoelscher, Springer, & Pohle—Industrial Production Illustration—$5.75
- ☐ Maerz & Paul—Dict. of Color—$25.00 (payable $5.00 in 10 days and $5.00 monthly)

(Print)
Name .....
Address .....
City .....Zone.....State.....
Company .....
Position PE-11

This offer applies to U. S. only

Noma Plays SAFE with Flame-Resistant Hercocel*

A new addition to Noma's distinguished line of Christmas ornaments is the Glo-lite Musical Santa, an animated plastic figure which can be used as a table or mantel lamp, or as a window decoration. The big brass button on Santa's coat winds a spring mechanism operating a Swiss music box. As it plays, Santa rings the bell held in his right hand.

In selecting a plastic for this new product, Noma played safe . . . chose Hercules* Flame-Resistant Hercocel, the material which has proved itself in more than two years of use in Noma's Bubble-Lites and "Fancy Figures." This unique plastic, pioneered by Hercules, offers all the features of regular acetate, plus the advantage of being a self-extinguishing material which can be injection molded.

Hercules Flame-Resistant Hercocel is bringing added color and sales appeal to a growing list of electrical products. Our technical staff will be glad to help you apply it to your own needs.

HERCULES POWDER COMPANY Cellulose Products Department, 90¼ Market Street, Wilmington, Del.

Another Noma safety feature is this new plug with built-in fuse. When used for all lights on tree, the entire tree is protected.

HERCULES Cellulosic Plastics

*TRADE-MARK

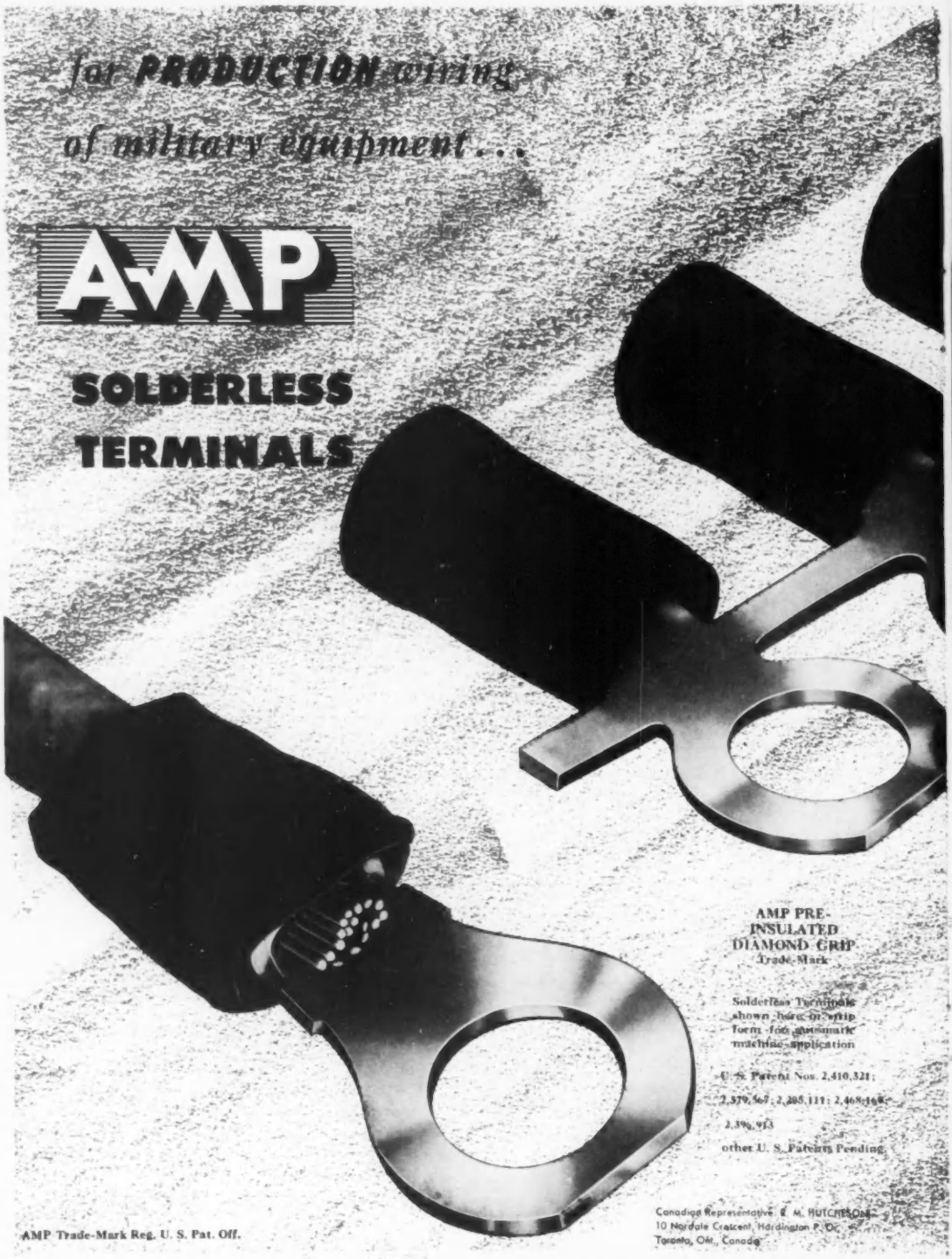
CP51-8

for **PRODUCTION** *wiring*

of military equipment . . .

AMP

SOLDERLESS TERMINALS



AMP PRE-INSULATED DIAMOND GRIP
Trade-Mark

Solderless Terminals shown here in strip form for automatic machine application

U. S. Patent Nos. 2,410,321; 2,579,567; 2,385,111; 2,468,168; 2,396,913

other U. S. Patents Pending

AMP Trade-Mark Reg. U. S. Pat. Off.

Canadian Representative: E. M. HUTCHISON
10 Nordale Crescent, Hardington P. O.
Toronto, Ont., Canada

NEW SPEED QUALITY UNIFORMITY

UP TO 4,000 COMPLETE, INSULATED CONNECTIONS PER HOUR WITH HIGH SPEED AMP AUTOMATIC MACHINES

SUPERIOR DESIGN, PRODUCTION, AND PERFORMANCE TOLERANCES

Critical stripping dimensions last set in manufacture of tool or terminal. This applies throughout wide range of hand, foot, pneumatic or automatic tools. Here are crimping devices suitable for every type of job at every production level.

AMP

AIRCRAFT-MARINE PRODUCTS INC.

2100 Paxton Street, Harrisburg 4, Pa.

Dependable DOERR* MOTORS

These improved Whiting hoists have fewer parts for lower maintenance with inherent features to provide maximum safety.

power WHITING ELECTRIC HOISTS

*Trade Mark

for increased production—greater handling efficiency

Whiting's wide acceptance in industry as a producer of reliable materials handling equipment is well known. We are privileged to be the major supplier of motors for Whiting Electric Chain Hoists.

you get More with DOERR!

DOERR Electric Corporation
(Electro Machines, Inc.)
CEDARBURG, WISCONSIN

Electric Motors from 1/30 to 5 hp. Standard, or Designed to Your Specifications.

If you have an unusual motor problem please let us hear from you.

Spincraft
SKILL WILL DO IT

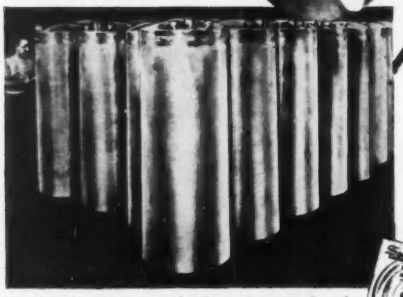
Production Methods Help You Gain Months of Time

Costs are *much* lower, too

Whenever emphasis is on speed in delivery, or lower costs, consider Spincraft metal fabricating. Of all the methods available for cold shaping flat or rolled sheet metals, the spinning lathe, plus special Spincraft forming skills, offers the fastest and least expensive means of getting production rolling. As an example, consider the parts and assembly for the water sterilizer unit illustrated here. From a scratch start Spincraft made the required tools, produced the components and assembly and began delivery ten days after receipt of the order. Months of time were gained, thousands of dollars saved.

Cases like this are everyday experiences at Spincraft — on both small and large runs. The answer you want cannot be guaranteed, but others have been helped so often and so well that Spincraft has become the world's largest metal spinning and fabricating plant. Call or write

Components for stainless steel water sterilizer—spun, fabricated and assembled in record time at lowest cost.



The function, scope, mechanics and economics of Spincraft metal spinning and fabricating are discussed in this stimulating 40-page, well-illustrated booklet. A copy is yours for the asking.

Spincraft
SKILL WILL DO IT
INCORPORATED

4139 W. STATE ST.
MILWAUKEE 8, WIS.

Heretofore known as Milwaukee Metal Spinning Co.

At Accurate

attention to all the details

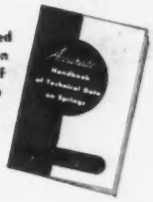
Thorough degreasing in the most modern equipment is just one of the "details" carefully attended to at Accurate.

lowers the overall cost of your springs

THE manufacture of springs, like the manufacture of your product, is *the* sum of details . . . and the attention *each* of these details receives determines the quality of the finished product. Here at Accurate, we feel that no detail is too minor to receive the careful attention of our skilled springmakers. The result: precision springs that exactly meet your specifications and do their part in assuring the fine performance your product was designed to give . . . and because of the rigid adherence to your specifications assembly is speeded up, inspections simplified and rejections minimized. This means substantially lower overall costs for you.

The best way to find out what Accurate can do for you is to give us a trial. For a quotation just send a drawing and specifications or, if you prefer, Accurate engineers will be pleased to assist you with your spring design problems. ACCURATE SPRING MFG. CO., 3815 West Lake Street, Chicago 24, Illinois.

Write for your copy of the new revised Accurate Handbook of Technical Data on Springs. This booklet has been out of print for some time and if you have previously requested a copy and have not received it, we would appreciate your asking again.



Be sure the springs you buy are Accurate

Accurate Springs

Springs
Wire Forms
Stampings

1. Low Installation Cost
2. Low Inspection Cost
3. Fewer Rejects
4. Less Returned Goods
5. Less Failures in Service
6. Satisfied Customers

WRITE: Belden Manufacturing Co.
4691 West Van Buren Street
Chicago 44, Illinois

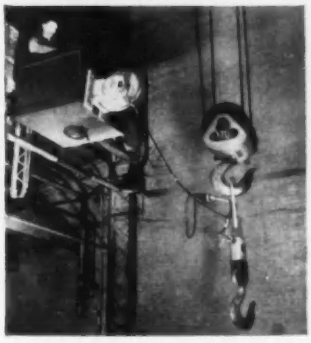
CORDITIS-FREE CORDS BY...

Belden **WIREMAKER FOR INDUSTRY**

Big Advancement in Industrial Weighing

Ametron ELECTRONIC SCALE and RECORDER

SIMPLIFIES BOTH THE EQUIPMENT, DESIGN AND THE *WEIGHING OPERATION*



● The Ametron Electronic Unit is easily installed in equipment and replaces cumbersome levers, pivots, and bearings of conventional scales.

● There is a cell for large or small capacity installations. In every case accurate results are obtained even under rapid motion weighing.

● The Recording Unit in two models — cabinet or panel — can be placed at any remote and convenient spot so that the weight is seen the instant the products are being weighed. Prints on ticket, tape, or a ledger.

The Ametron Electronic Scale records the accurate weight applied to the load cells by printing on ticket, tape, or ledger sheet. It has applications where weighing is done on steel, iron, and other heavy products—also for railroads, truckers, shippers, mine operators, and factories—whether it is a dormant or motion weighing application.

The unit makes weighing easier, quicker and more exact. Being compact, installation is simple as compared with complicated lever systems. It eliminates problems encountered in maintenance because of accessibility of load cells and interchangeability of cells and recorder components.

The Recorder is a full figure step cam controlled mechanism. It includes provision for multiple ranges to give increased capacity with high sensitivity and accuracy. Both the load cells and intruments are designed to operate over wide ranges of temperature.

Our Sales Engineering Department is prepared to assist you in finding the most practical and economical answer in applying the Ametron Electronic Scale.

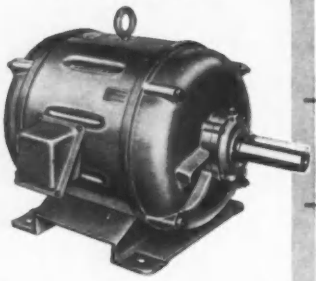
STREETER-AMET COMPANY

4101 RAVENSWOOD AVENUE **CHICAGO 13, ILLINOIS**

Branches in Pittsburgh, Pa. and Birmingham, Ala.

Wagner Quality Motors--

POLYPHASE SQUIRREL-CAGE MOTORS

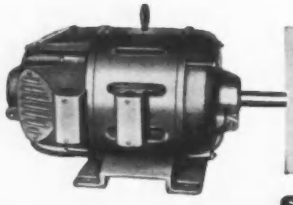


Wagner integral horsepower open type polyphase squirrel-cage motors in frames 326 and smaller are completely dripproof in the normal, sidewall or ceiling horizontal positions, because there are no ventilating openings in the frame. Larger open type motors are not dripproof, but dripproof construction for normal horizontal mounting can be supplied if required.

ELECTRICAL TYPES

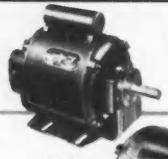
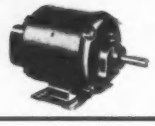
TYPE	CHARACTERISTICS	RATINGS	APPLICATIONS
RP-1	Normal torque, normal slip (approximate full-load slip less than 5%)	¼–400 hp, 3- or 2-phase, 25 to 60 cycles, all standard voltages.	Group or individual drives on machine tools, fans and blowers, compressors, centrifugal pumps—on any application where normal torque motors are satisfactory.
RP-5	High torque, normal slip (approximate full-load slip less than 5%)	1½–200 hp, 3- or 2-phase, 60 cycles, all standard voltages.	Crushers, plunger pumps, belt conveyors starting under load, large air compressors, large refrigerating machinery, mixers and other high starting torque applications.
RP-6	High torque, high slip (approximate full-load slip 5 to 8% or 8 to 13%)	½–150 hp, 3- or 2-phase, 25 to 60 cycles, all standard voltages.	Punch presses, shears, metal drawing operations, balers and other machinery equipped with flywheels or having flywheel effect.
RP-7	High torque, high slip (approximate full-load slip 15 to 18%)	1–60 hp, 3- or 2-phase, 25 to 60 cycles, 110 to 550 volts.	Elevators, cranes, hoists, dumbwaiters.

WOUND-ROTOR POLYPHASE MOTORS



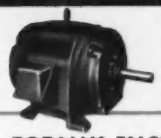
RS-1	Continuous Duty... constant or adjustable varying speed.	1 to 250 hp. 3- and 2-phase, 25 to 60 cycles, 110 to 550 volts.	Conveyors, compressors, pulverizers, etc., requiring continuous operation.
RS-2	Intermittent Service... Crane and hoist duty.	2 to 200 hp. 3- and 2-phase, 25 to 60 cycles, 208 to 550 volts.	Elevator, crane, hoist and similar services requiring short periods of operation.

SINGLE-PHASE MOTORS

MOTOR TYPES	CHARACTERISTICS	OPEN TYPE RATINGS	MOTOR-TYPE VARIATIONS
 RK	Capacitor-start induction, high starting torque, normal starting current. For general purpose single-phase applications.	⅛–3 hp, sleeve or ball bearings, rigid or resilient base. 115, 230 or 115/230 volts, 25 to 60 cycles.	Type TK, totally enclosed non-ventilated ⅛–½ hp.
RA	Repulsion-start induction, high starting torque, low starting current. For general purpose single-phase applications.	½–15 hp. Sleeve bearings, rigid base all ratings; ball bearings through 7½ hp; resilient base through 1½ hp. 115/230 volts (fractional), 110/230 volts (integral), 25 to 60 cycles.	Type TA, totally enclosed non-ventilated, ½–3 hp. Type HA, totally enclosed non-ventilated explosion proof, ½ hp.
RG	Repulsion-induction, high starting torque, for applications involving a very long starting period.	1–5 hp. Sleeve or ball bearings, rigid base. 110/220 volts, 60 cycles.	Type HG, totally enclosed fan-cooled explosion proof, 1–3 hp.
 RB	Split-phase induction, low starting torque, high starting current. For easy to start small fractional hp applications.	1/20–⅓ hp, sleeve or ball bearings, rigid or resilient base. 115 or 230 volts, 25 to 60 cycles.	Type TB, totally enclosed non-ventilated, 1/20–⅓ hp.

...for your product or your plant

ENCLOSURE TYPES

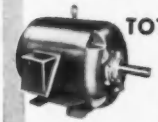


SPLASHPROOF

Type XP-1, normal torque, ¾–125 hp, and type XP-5, high torque, 3–50 hp. 50°C, single speed, ball bearing, rigid base, horizontal.

TOTALLY ENCLOSED NON-VENTILATED

Type TP-1, normal torque, ¼–15 hp. 55°C, single speed, sleeve or ball bearings, rigid base, horizontal.



TOTALLY ENCLOSED FAN-COOLED

Steel Frame Construction

Type CP-1, normal torque, 1–250 hp; type CP-5, high torque, 3–75 hp. Standard.

Type HP-1, normal torque, 1–250 hp; type HP-5, high torque, 3–75 hp. Explosion proof.

Cast Iron Frame Construction

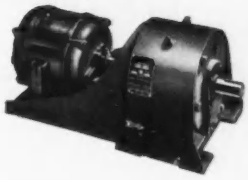
Type EP-1, normal torque, 2–250 hp; type EP-5, high torque, 3–75 hp. Standard.

Type JP-1, normal torque, 2–250 hp; type JP-5, high torque, 3–75 hp. Explosion proof.

MULTISPEED MOTORS

Multispeed squirrel-cage motors are used where more than one running speed is required, but where close speed regulation is not required. They are built with the same electrical characteristics and the same types of enclosure as single speed motors.

CHARACTERISTICS	SPEEDS	APPLICATIONS
Constant Torque motors have the same torque ratings at each speed and the horsepower varies directly as the speed.	2, 3, or 4	Typical applications; stokers, conveyors, printing presses.
Variable Torque motors have torque ratings which are directly proportional to the speeds and consequently the horsepower varies as the square of the speed.	2, 3 or 4	Typical applications; fans, blowers, centrifugal pumps and similar applications.
Constant Horsepower motors have the same horsepower rating at each speed and the torque varies inversely with the speed.	2, 3 or 4	Typical applications; lathes, boring machines and other machine tools.

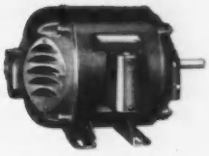


GEAR MOTORS

Wagner single-phase and polyphase squirrel-cage motors, open and enclosed types, combined with nationally known gear units. 1/20 to 50 hp. with speeds and mountings to meet most requirements.

DIRECT CURRENT MOTORS

A companion line to Wagner alternating current motors, built to enable appliance and machinery manufacturers to supply Wagner motors on units destined for areas served with direct current. 1/6 to 3 hp, sleeve or ball bearings, rigid or resilient base, 115 and 230 volts.



INCREMENT TYPE MOTOR AND STARTER COMBINATION

A low-cost combination of a polyphase squirrel-cage motor, wound with two parallel star circuits, and a magnetically operated two step increment type starter, which limits the inrush of current at starting.

JET PUMP MOTORS

Type RK—Single-phase, capacitor-start, open type, 40°C. with round frame, ball bearings, and NEMA face type back endplate for horizontal or vertical end mounting. Built to NEMA standard dimensions and performance, in ratings ⅙ to 1 hp, 60 cycle 3600 rpm, 50 cycle 3000 rpm, 115/230 volts.

FAN DUTY MOTORS

Type TM — Shaded-pole, totally enclosed non-ventilated, no temperature rating, for shaft mounted propeller fans which draw air over the motor. 1/125, 1/80, 1/40, 1/30 and 1/20 hp; sleeve bearings, round frame or with rigid or resilient base. 3 speed reactor controllers can be supplied if specified.

DRY-TYPE TRANSFORMERS

Type AE—Two coil single-phase. Ratings 1–10 kva—Designed for wall mounting, and suitable for indoor or outdoor installation. Approved by National Board of Fire Underwriters. Ratings 15–200 kva—Designed for floor or platform mounting. For indoor service only. Type AP two coil three-phase dry-type transformers and Type AA single-phase dry-type auto-transformers are also available.

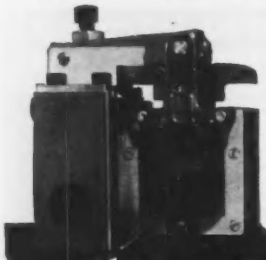
WAGNER ELECTRIC CORPORATION
6406 Plymouth Ave., St. Louis 14, Mo., U.S.A.

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS – AIR AND HYDRAULIC

BRANCHES IN 31 PRINCIPAL CITIES

SOLENOID VALVES

have working pressures range as high as 3000 psi. They were specifically designed for remote push button control of hydraulic systems, as well as for the handling of any non-corrosive fluids. The poppet construction eliminates leakage. The impregnated coils are oil and moisture resistant. The unit can be mounted in any position.



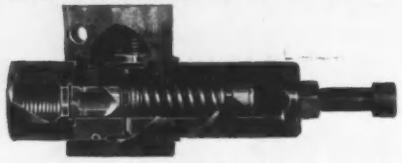
PRODUCTS OF

Waterman

ENGINEERING COMPANY

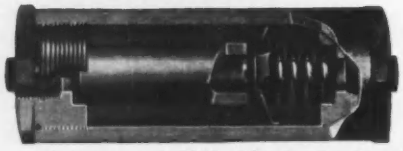
725 CUSTER AVENUE
EVANSTON, ILLINOIS

ADJUSTABLE FLOW REGULATORS



for cylinder speed control over a 50% range are built for pressures to 3000 psi. Model 320 shown meets requirements for cylinder speed adjustment yet maintains constant speed regardless of work or pressure fluctuations. There are types for Machine Tools—Earth Moving, Material Handling and Farm Equipment—Packaging Machinery—Steel and Paper Mills—Refineries—Oil Fields and Printing Presses.

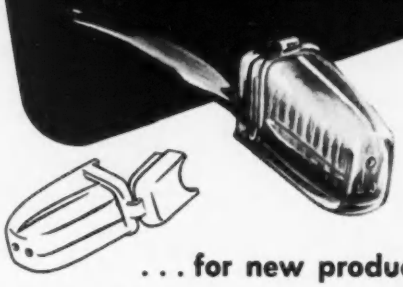
MICRONIC LINE FILTERS



are made in pressures to 3000 psi for air, oil, water and other fluids. They are compact permitting more simplified design, have built-in durability, and are easy to clean. The Micronic element filters to 40 Microns providing full protection for pumps, valves and cylinders. The elements which are low in cost are easily replaced. They make possible maximum flow with a minimum pressure drop.

WRITE FOR OUR ENGINEERING COOPERATION AND FURTHER DETAILS

Sell-ective manufacturers choose SHAW



. . . for new product designs in Thermoplastics

When you want new ideas in plastics, follow the example of other smart manufacturers — call Shaw! From design and development to materials handling, Shaw's extensive facilities and molding know-how are your guarantee of the best possible product . . . at the lowest possible cost.

The Tu-B-Tec Toothbrush Protector, (illustrated) designed and molded for Simmons Kit Co. well demonstrates Shaw facilities in action. The problem was to develop a toothbrush protector which was smartly styled, compact, able to withstand rough usage, and still be extremely low-cost. Shaw's solution more than meets these requirements . . . and through conservation of the Thermoplastic material inherent in the design, plus the proper molding methods—it is produced for 1/10 of the former model's cost!

Its advantages of a self-hinged closure . . . molded in lightweight, unbreakable, chemically inert polyethylene; are making Tu-B-Tec the most successful toothbrush case on the market.

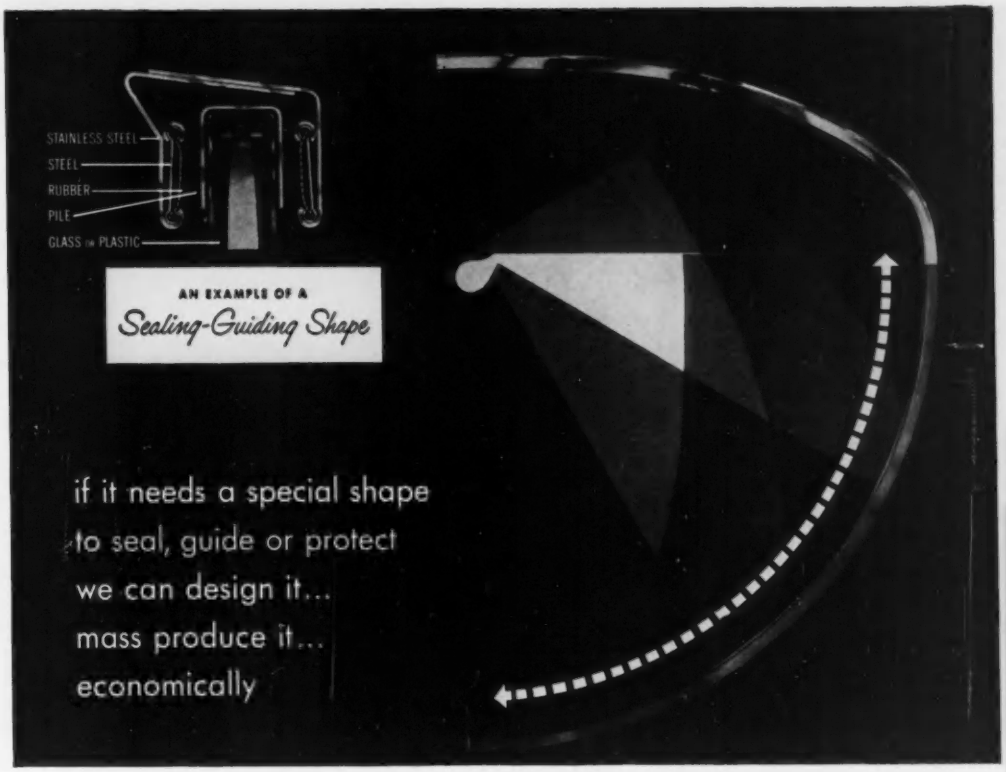
NOTE: Let SHAW solve your plastic problems
Write for Free brochure, today!

SHAW INSULATOR COMPANY

SHAW

MOLDERS SINCE 1892

160 COIT STREET IRVINGTON 11, N. J.



Perhaps your product has a panel, door or window that slides, lifts or swings. It may need a guide or channel to control its motion. It may require a seal against heat or cold, dust or moisture.

If so, we can design a shape to meet your specific need. We can mass produce it at low cost—in metal, rubber, plastic or fabric. And we can bond together any combination of them, through unique processes we have developed.

The result may be a special shape, such as the window channel and seals we produce as original equipment for leading motor car manufacturers, with either electrical or manual control. Or it may be a complete *assembly*, specially engineered to solve your particular sealing or guiding problem. We are now turning out such assemblies for military equipment.

If this design experience and specialized manufacturing approach suggest a solution to one of your problems, we'd like to discuss it with you. Or write for a copy of our new booklet, "We Put Ingenuity into SHAPE," which further explains our facilities.

THE MARK OF A SUPERIOR PRODUCT

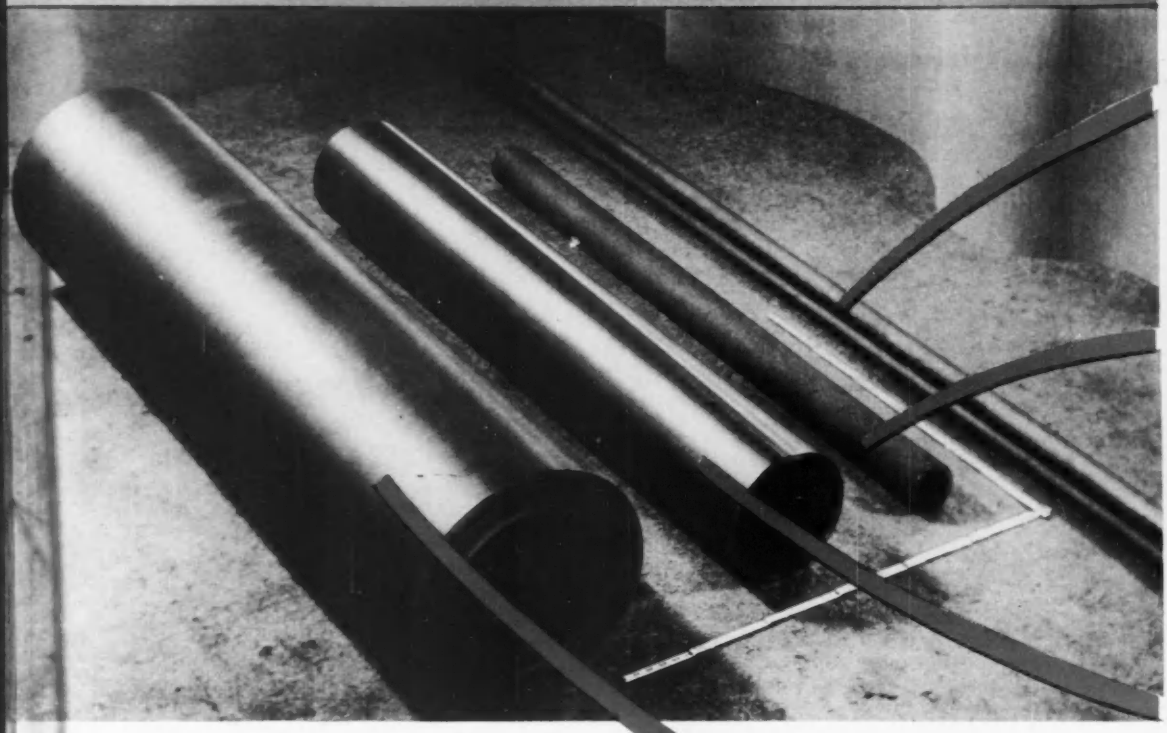
The Standard Products Co.

DEPT. D. GENERAL OFFICES: 2130 WEST 110 STREET • CLEVELAND 2, OHIO

WE PUT INGENUITY INTO SHAPE

quality + economy

YOU ARE SURE OF BOTH WITH THE VERSATILE METAL MOLD PROCESS



Rarely does a process as new, relatively speaking, as Metal Mold Centrifugal Casting score so many outstanding successes in so short a time . . . and in such varied fields of application. This remarkable acceptance is probably due, in great part, to its unusual versatility.

These applications cover a wide range of cylindrical products in gray and alloy iron, as well as carbon, low alloy and stainless steel. Four typical uses in gray and alloy iron are shown at the right.

Regardless of the end use, one factor remains constant: high quality at low cost. Metal soundness, uniform wall thickness, ease in machining, and broad size range are assured when you specify Metal Mold Centrifugal Casting.

We have a brochure describing the uses and possibilities of Metal Mold Centrifugal Casting which many engineers and production men have found valuable. If you would like to have a copy, write us here in Burlington.

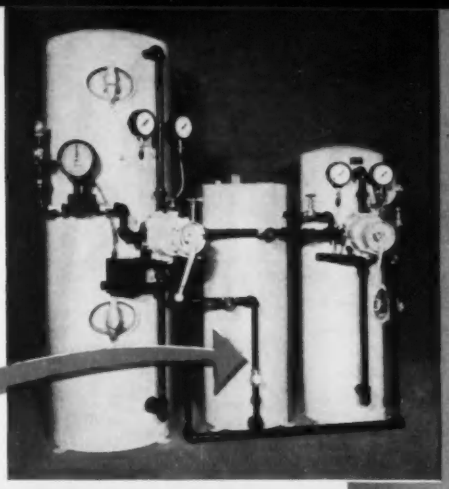
UNITED STATES PIPE & FOUNDRY CO.

SPECIAL PRODUCTS DIVISION USP

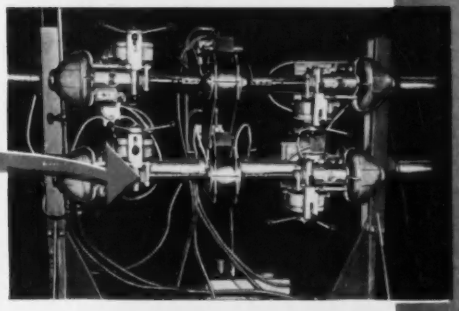
Special Products Division

BURLINGTON, NEW JERSEY

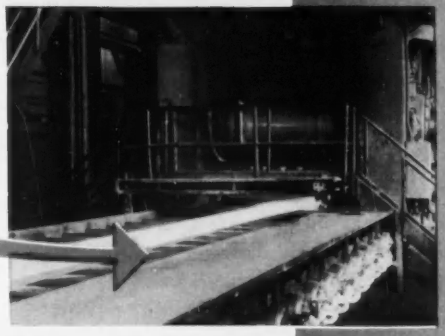
AMERICA'S LARGEST PRODUCER OF CENTRIFUGALLY CAST FERROUS METAL PRODUCTS IN TUBULAR FORM



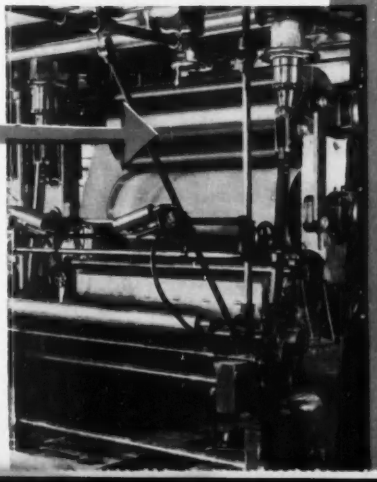
CONCENTRIC, SOUND AND EASILY MACHINED— The lower range of casting sizes for the versatile Metal Mold centrifugal casting process is illustrated by the small iron tubing (1½" IPS) used in this popular Inversand Water Filter and Softener (courtesy Hungerford & Terry, Inc.). The excellent concentricity, soundness and uniformly good machining characteristics make this iron tubing most useful for processing equipment. Considering the relatively low cost, it exemplifies "quality with economy".



CLOSE DIMENSIONAL CONTROL AND SOUNDNESS— The columns of this machine—a combination of 4 standard Walker-Turner 20" power feed drill heads—(courtesy Walker-Turner Division of the Kearney & Trecker Corporation) typify the close dimensional control and soundness obtainable with Metal Mold centrifugal castings. These straight, close-grained cast iron columns offer many advantages—good damping properties, high compressive strength, freedom from "hard" and "soft" spots and machinability reportedly 20% better. Prices are competitive.



TAILOR-MADE TO STAND UP LONGER—The miles of steel carried by the centrifugally cast run-out table rollers in this Hot Strip Mill (courtesy United Engineering and Foundry Company) call for a "tailor-made" alloy iron capable of taking the shock, wear and abrasion that continuous service demands. The Metal Mold process provides table rollers that meet all of these severe requirements.



MOST EFFICIENT AND ECONOMICAL WHERE MASS AND WEIGHT ARE "MUSTS"— Padder and squeeser rolls of the type illustrated in this three-roll heavy duty padder (courtesy Morrison Machine Company) are made of gray iron and represent the upper range of the Metal Mold centrifugal casting process. In applications of this nature, where mass and weight are required, no other material can do the job as economically and as efficiently as gray iron.

Request For Action...

ATLAS POWDER COMPANY
Industrial Finishes Department

CUSTOMER REQUEST

Register No.:
Sample No.:
Date Promised:
Shipped: Via:

1. Customer:
Street:
City & State:
Date:
Salesman:
Date Wanted:
Attention: Mr.:
Company:
Street:
City & State:

2. Send: gallon sample
gallon reducer
finished panels
finished parts

3. Customer sending wet sample ( ) Color chip ( ) Parts for finishing ( )

4. Material Requirement: Specify grade or finish type

5. Match color to: Match gloss to:
Item being finished: Made of:
Surface preparation:
Undercoats (if any): Topcoats (if any):

METHOD OF APPLICATION
( ) Tumbling ( ) Roll Coating ( ) Squeegeeing ( ) Wiping ( ) Flowing ( ) Whirling
( ) Spraying-Air Pressure Pounds ( ) Gravity Feed ( ) Pressure Feed Pounds ( ) Cup Gun
( ) Dipping - Drip Time ( ) Hand Dip ( ) Automatic Dip ( ) Withdrawal Speed
( ) Automatic Spraying ( ) Electrostatic Spraying ( ) Electrostatic Detearing

REDUCTION
Reducer desired: Reduction desired: to
Reducer desired: To recoat: To pack:

AIR DRYING
Dust free: To handle:

OVEN TYPE
( ) Box Oven ( ) Direct Fired ( ) Indirect Fired ( ) Electric Heat
( ) Infra Red (Electric) ( ) Infra Red (Burdett) ( ) Conveyor Oven

BAKING CYCLE
Time to Peak Heat Time at Peak Time from Peak Peak Temp.

SAND., ETC.
Sanded in Hrs. Rubbed in Hrs. Polished Hrs. What Abrasive What Lubricant

6. Monthly consumpt

ZAPON *Service From Every Angle* starts with the Customer Request. It is the spring board for action in the customer's interest. Infinite details must be checked and re-checked—the thousand and one "little things" that can become real problems.

ZAPON technicians overlook nothing that helps assure a finish that charms the eye on the sales floor and stands up to daily use and abuse . . . or that meets exacting government "specs."

Let a ZAPON Customer Service representative prove *Service From Every Angle* to you.

Service from every angle... that's

ZAPON
REG. U.S. PAT. OFF.

ATLAS POWDER COMPANY

Industrial Finishes

Stamford, Conn. • North Chicago, Ill.

LaPLANT-CHOATE *HYDRAULIC UNITS* make the Gradall do things ONE MACHINE never did before

LPC HYDRAULIC UNITS combine Speed, Power, Versatility, Simplicity and Trouble-Free Operation to make GOOD equipment still BETTER!

FOR this multi-purpose construction machine, Gradall engineers wanted precision work for a wide variety of jobs from excavating to snow removal . . . work that was out of the reach of ordinary construction machines. That's why they selected 7 LaPlant-Choate hydraulic jacks and 3 pumps . . . to provide maximum power, operating smoothness and precision, instant response to controls and trouble-free operation.

For a Compact, Complete Hydraulic Installation Use the Famous LPC Fluid Power Control

Pump, valve and oil reservoir are all combined into a single compact unit. This new "closed system" design completely eliminates long suction lines, reduces the hazard of leaks and assures greatly increased speed and efficiency. In addition, the entire unit is skillfully engineered and precision built for utmost simplicity, easy servicing and long, trouble-free operation.

Design your product for better performance

When you standardize on LaPlant-Choate Hydraulic Equipment for your product, you can be sure of greater sales advantages that add up to more profit. Here are a few of the features that will make your product better—*Compact Design* with the all-in-one fluid power control; *Versatile Application* for any type of equipment; *Multiple Use* of one installation with multiple valves, combinations and oil circuit variations; *Positive Finger-tip Control* for operating accuracy and precision; *Easily Installed* and adaptable to a wide choice of mountings; *Low Maintenance* and *Long Life* under the most adverse operating conditions.

Write for complete information about making your products easier to design, manufacture, sell and service. Ask for Bulletin B-1152B.

LaPlant-Choate Manufacturing Co., Inc.
Cedar Rapids, Iowa

LAPLANT CHOATE

Sweet's File for Product Designers

1 materials

metals	a
metal fabricators	b
plastics	c
plastic processors and fabricators	d
rubber	e
wood	f
glass	g
other materials	h

2 finishes

lacquers, enamels and coatings	a
decalcomania	b

3 electrical parts

motors and generators	a
controls	b
other electrical parts	c

4 mechanical parts

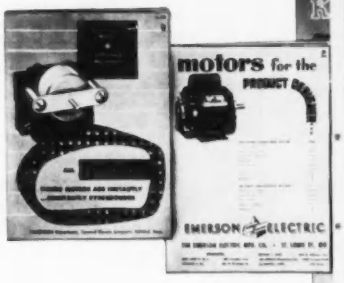
transmissions	a
flexible shafts	b
bearings	c
hydraulic and pneumatic equipment	d
pumps and compressors	e
instruments and controls	f
lubricating systems	g
flexible tubing and hose	h
fittings and valves	i
gaskets, packing and oil seals	k
fastening devices	L
other mechanical parts	o

5 techniques

welding, brazing, hardening	a

6 work equipment

duplicating equipment	a



looking for electrical parts?

reach for Sweet's **All these manufacturers' catalogs—containing comprehensive information on motors, controls, and other electrical parts—are instantly available in Section 3 of your new 1952 Sweet's File for Product Designers.**

The other sections of this Sweet's File contain additional catalogs covering a wide range of materials and equipment . . . useful and up-to-date information on product forms, characteristics, performance and use.

This grouping of manufacturers' catalogs, in sections according to products or use of products, is made for your convenience, so that you can more readily compare one product with another. Indexes of manufacturers, products and trade names lead you quickly and easily to the catalogs you are looking for.

Sweet's is working constantly to get more manufacturers to send you their catalogs in this easy-to-use form. If you fail to find what you want, please tell us.

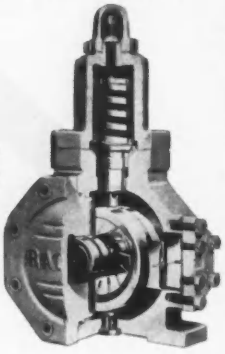
Sweet's catalog service

DIVISION OF F. W. DODGE CORPORATION 119 WEST 40th STREET NEW YORK 18, N. Y.

Put ALL of the Oil to Work--

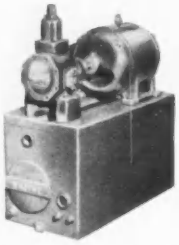
WITH

RACINE

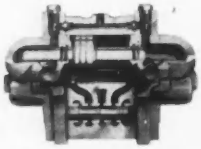


OIL HYDRAULIC PUMPS

A visible leak in your hydraulic circuit would be stopped quickly. Bypassed oil is a "leak" in your circuit. A loss to you. RACINE Variable Volume Pumps, with their automatic governors, deliver only the volume of oil needed for the job. There is no excess to be lost through relief valves, to heat the circuit, to waste horsepower. Simplicity, efficiency, a lower first cost are yours when all elements of the circuit are productive — and all the oil is on the job. RACINE Variable Volume Pumps, Valves and other hydraulic units can add much to your hydraulic equipment. Write for catalog P-10-D. It's new and complete.



PUMP AND RESERVOIR UNITS



HYDRAULIC BOOSTER

HYDRAULIC 4-WAY VALVES

Write for the new, 3-color hydraulic catalog P-10-D — for the full story on RACINE Variable Volume Pumps, Valves, Boosters and Package Units. Address Racine Tool & Machine Co., 1772 State Street, Racine, Wisconsin.

STANDARD FOR QUALITY AND PRECISION · RACINE TOOL and MACHINE CO. ·

RACINE

STANDARD FOR QUALITY AND PRECISION

VULCAN

ELECTRIC HEATING UNITS

On Airplanes

in high altitudes and sub-zero temperatures, Vulcan Electric Heating Units hold lubricants in a liquid state.

They're used also as anticipators in thermostatic control: in guided missiles and in speed indicators.

Vulcan electric heat is helping in many new inventions for both war and peace. To assist in the further development of your ideas, Vulcan heating designers will be glad to join their know-how to yours.

VULCAN ELECTRIC CO.
DANVERS 18, MASS.

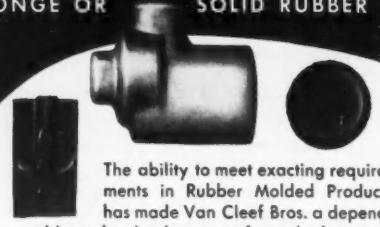
Makers of Vulcan Electric Soldering Tools, Electric Solder Pots, Electric Glue Pots, Electric Branding Irons and Electric Heating Units.

RUBBER MOLDED PRODUCTS

made to your specifications

NATURAL • SYNTHETIC

SPONGE OR SOLID RUBBER



The ability to meet exacting requirements in Rubber Molded Products has made Van Cleef Bros. a dependable and valued source of supply for many manufacturers who require nothing short of precision. This has made customers of long standing. Send your drawings, outline your requirements and let us quote on your precision molded rubber parts.

DUTCH BOY BRAND

VAN CLEEF BROS. INC.
Manufacturers Rubber Products Est. 1910
7800 WOODLAWN AVENUE • CHICAGO 19, ILLINOIS

Laminated Plastics Problems?

MAKE TAYLOR YOUR HEADQUARTERS FOR FULL-LINE SERVICE

If you are a hard-to-please customer who demands the best in laminated plastics and insists on service, why not join the hundreds of companies who now enjoy the plus-values of Taylor *full-line* Service?

Yes, from *one* supply source you can get Taylor Vulcanized Fibre, Phenol Fibre, and Glass Melamine and Silicone Laminates in a wide variety of grades—in sheets, tubes, rods, strips and coils. You'll find a dependable source of supply, too, for precision-made parts fabricated to your specifications having the physical, electrical, mechanical and chemical characteristics you require. And, you'll find the engineering assistance you need when you're stymied with *any* problem involving laminated plastics.

Whether we have the opportunity of serving you from our main plant at Norristown, Pa., pictured above, or from our West Coast plant at La Verne, California, you are assured of the same Taylor quality products and full-scale service.

Taylor

TAYLOR FIBRE CO.

NORRISTOWN, PENNSYLVANIA

WEST COAST PLANT: LA VERNE, CALIF.

OFFICES IN PRINCIPAL CITIES

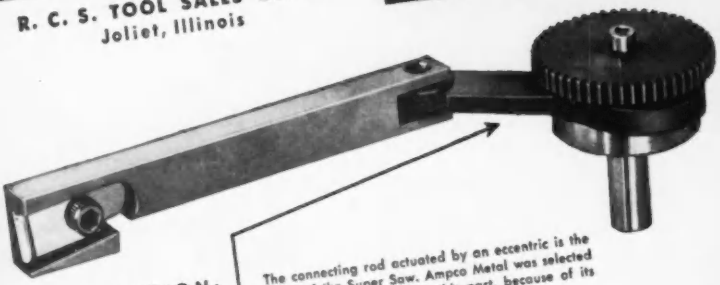
Here is the Taylor 62-page catalog. It contains specifications and description of Taylor Laminated Plastics. See for yourself how you can make your product or part better with the use of these plus-value materials. Write today for Catalog PE11.

FIGHT WEAR

...in both Product and Plant

New RSC Super Saw attachment for heavy-duty ¼" electric drills provides an all-purpose, portable power-saw for cutting wood siding, "Insulbrick," "Ebonite," "Transite," fibre, Formica, galvanized sheet and other metals, cable, pipe, wire, nails, etc., — any shape: curves, angles, circles. No starting hole is needed.

R. C. S. TOOL SALES CORP.
Joliet, Illinois



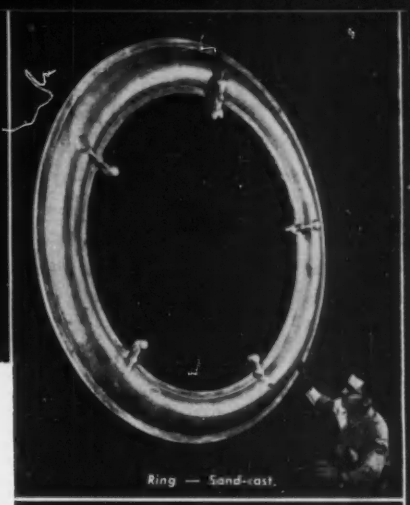
APPLICATION: The connecting rod actuated by an eccentric is the heart of the Super Saw. Ampco Metal was selected as the ideal material for this part, because of its high strength and ability to resist wear.

RESULT: The Super Saw can be used for continuous service, day in and day out.

IT'S PRODUCTION-WISE TO AMPCO-IZE!

Gear blank — Centrifugally-cast

Centrifugal Casting



Ring — Sand-cast.

---with

AMPCO* METAL

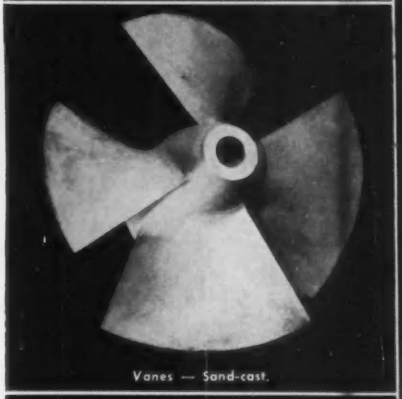
You can save plenty of money and eliminate lots of trouble with high-strength Ampco Metal.

You see, Ampco Metal resists wear — such types of wear as erosion, abrasion and cavitation-erosion. It also resists corrosion. That's why so many designers are putting Ampco Metal to work in their products. They want longer part life, better performance.

Moreover, thanks to its various hardness ranges, Ampco Metal is ideal for a wide variety of product services and plant-maintenance jobs. It resists both wear and squashing out — stands up under the heaviest kind of service.

And Ampco Metal is easy to use. It's available in bars, sheet, plate, tubing, sand and centrifugal castings, forgings, wire and welding electrodes — practically any form you want. When extra performance life is needed both in manufactured products and in production, specify Ampco Metal. Consult your nearest Ampco field engineer or send coupon for further information.

*Reg. U. S. Pat. Off., Ampco Metal, Inc.



Vanes — Sand-cast.

Bushings — Centrifugally-cast Ampco Grade 18 standard bars.

Tear out this coupon and mail today!

Ampco Metal, Inc.
Milwaukee 46, Wisconsin

AMPCO

West Coast Plant
Burbank, California

AMPCO METAL, INC., Dept. PE-11, Milwaukee 46, Wisconsin

Send me your free Ampco Metal literature giving descriptions and general applications of Ampco Metal.

Name..... Title.....

Company.....

Company Address.....

City..... (.....) State.....

D-8

SHENANGO *Centrifugal* CASTINGS ... KEY TO SAVINGS

Typical of some of the larger parts cast centrifugally and precisely finished at Shenango, this is a 45" cylinder bushing for use in a big hydraulic metal forming press.

CENTRIFUGALLY CAST BY SHENANGO . . .

for a longer life under pressure

THERE'S a way to save important money on symmetrical parts subjected to high pressures and stresses. You can do as so many companies do—turn to Shenango for *centrifugally* cast parts or assemblies . . . large or small . . . ferrous or non-ferrous . . . semi-machined or precisely finished to specifications.

At the modern Shenango works you'll gain by the most advanced techniques in centrifugal casting. Metal for metal you get greater strength and better resistance to wear or abrasion, to say nothing of relief from sand inclusions, blow holes and other often hidden defects.

GET ALL THE FACTS on Shenango time-and-money-saving service and qualities. Send for Bulletin No. 150 on non-ferrous parts; Bulletin No. 151 covering parts of Meehanite Metal, Ni-Resist and special alloy irons.

SHENANGO-PENN MOLD COMPANY
690 West Third St. • Dover, Ohio
Executive Offices: Pittsburgh, Pa.

SHENANGO

ALL RED BRONZES • MANGANESE BRONZES • ALUMINUM BRONZES
MONEL METAL • NI-RESIST • MEEHANITE METAL

Alumibonding

is basically a casting process—the bonding layer being an intermetallic compound of the two joined metals. Pure aluminum and the generally used casting alloys can be bonded by this process to cast iron, carbon and alloy steels, or stainless steel. Heat treatment after bonding is possible

APPLICATIONS

Applications of the ALUMIBONDING process of molecularly bonding aluminum and its alloys to steel or iron may be grouped into four classes:

LIGHTWEIGHT

Combining the lightness of aluminum and the strength of steel and taking advantage of the machinability of aluminum.

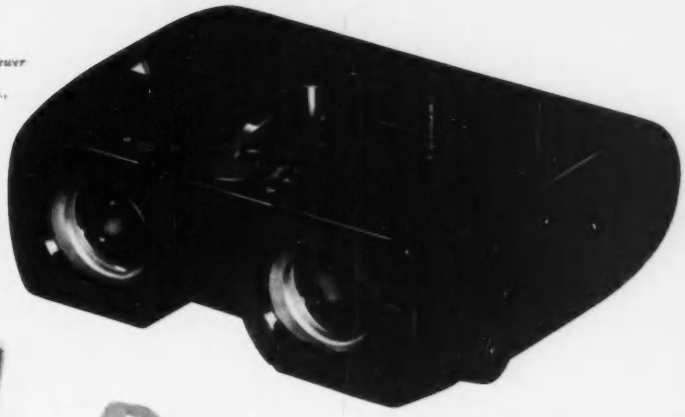
HEAT DISSIPATION

BEARING PROPERTIES

CORROSION RESISTANCE

WRITE TODAY FOR ALUMIBOND* BOOKLET

ARTHUR TICKLE
ENGINEERING WORKS
27 Delevan Street
Brooklyn 31, N. Y.
Telephone: Main 5-4200
*Copyright 1951

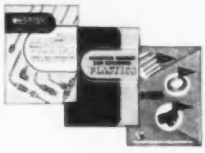


Verascope Stereo Viewer
Molded for
Busch Camera Corp.,
Chicago

Skillful Molding views a true-to-life picture!

Look at this viewer and you will see much more than a skillfully molded housing for a superb stereo optics system. You will see another reason why we are especially well equipped to mold your camera and photographic products—or any thermoplastic products for that matter. We can tell you a long story of product molding and engineering accomplishments. There's plenty of variety in this story for we have molded low cost mass production items, as well as outstanding sellers in the luxury price class.

Thus we know how to strike the proper balance of quality and economy that results in a top grade job within your production budget. We'd like to show you how we can do the best custom molding job for you. Let us know today where and when we can tell you our story.

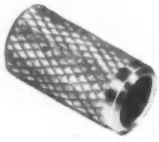


Write on your letterhead for the new Injection Molded and Extruded Plastics Catalog. Or, for detailed information about [redacted] piping, tubing and fittings, write for circulars containing data and illustrations.*
**Trademark Registered*

ELMER E. MILLS CORPORATION

INJECTION MOLDERS and EXTRUDERS of: Tenite, Lumarith, Plastacele, Fibestos, Lucite, Nylon, Plexiglas, Polystyrene, Styron, Loalin, Vinylite, Geon, Plexene, Polyethylene, Cerex, Fortisol, [redacted]*, Saran, and other Thermoplastic Materials.

2930 NORTH ASHLAND AVENUE • CHICAGO 13, ILLINOIS



TO produce many thousands of cast bronze bearings day after day, to the uniformly high quality synonymous with the name Bunting requires precise foundry control. This control starts with the raw materials necessary for production such as molding and core materials, core binders, fixed carbon fuel, prealloyed metal in ingot form purchased to Bunting's own rigid specifications, and virgin metals used for ladle additions to control metal composition. Then, too, melting and casting procedures are carefully controlled for the following reasons:

1. To keep gas absorption during melting to a minimum, thus assuring sound, gas-free castings.
2. To effect complete deoxidation of the metal in the ladle before pouring.
3. To insure that each particular casting is poured at the precise metal temperature consistent with highest quality.
4. To insure that molding and core materials are so processed that the correct properties are obtained for good castings, and
5. To insure metal of uniform composition meeting the specification.

Trained foundry and laboratory personnel are required to carry on this exact control as well as chemical and metallurgical equipment of the latest design. Bunting has always taken pride in being the leading producer of bearing bronze of the highest quality and has the facilities to maintain this leadership. The Bunting Brass & Bronze Company, Toledo 9, Ohio. Branches in principal cities.

86

Bunting®

BRONZE BEARINGS

BUSHINGS

PRECISION BRONZE BARS

Standardizes on NORGREN

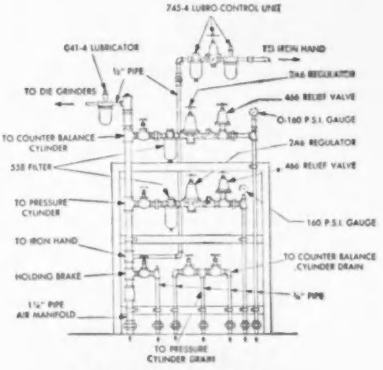
for air-control panels on all large presses

Minimizes...

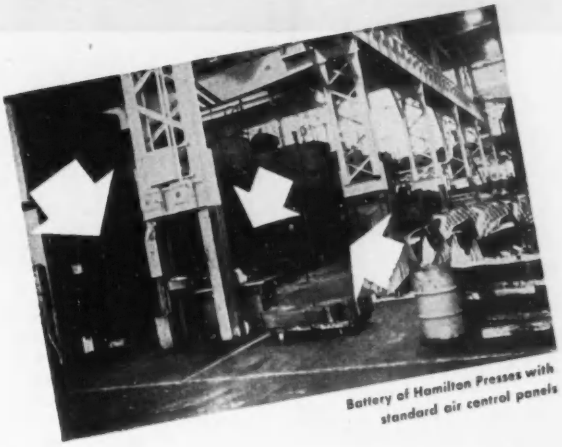
Service Operations

• Spare Parts Stock • Maintenance Costs

One of the Nation's largest, most modern automotive press plants uses 8 Norgren units (exclusively) in each air control panel for all large Hamilton presses. Standardized piping and control hook-ups for substantial savings and greater press efficiency.



For complete data write for
APPLICATION DATA SHEET No. 110
C. A. Norgren Co., 228 Santa Fe Drive, Denver 9, Colo.



Battery of Hamilton Presses with standard air control panels

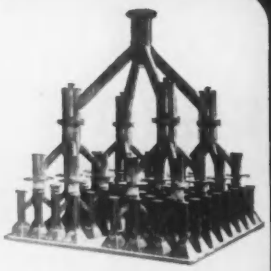
A Norgren Lubro-Control unit filters, regulates, and lubricates air to the "iron hand" which automatically pulls stampings from the press. Norgren Filters, Regulators, and Relief Valves serve the pressure and counterbalance cylinders...and a Norgren Lubricator serves air tools, such as die grinders, etc.

Norgren

Lubricators, Regulators, Filters, Relief Valves, Check Valves, Air Governors, Needle Valves, Hose Assemblies and Couplings.

25 YEARS OF HELPING AIR POWER SERVE INDUSTRY BETTER

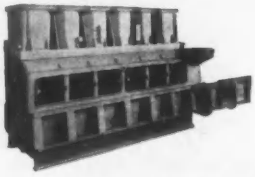
Steel-Weld FABRICATION



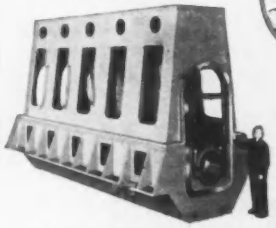
One of Several Parts of a Catalytic Cracking Plant Produced for the Petroleum Industry.

Pressure Vessels for the Chemical and Allied Industries.

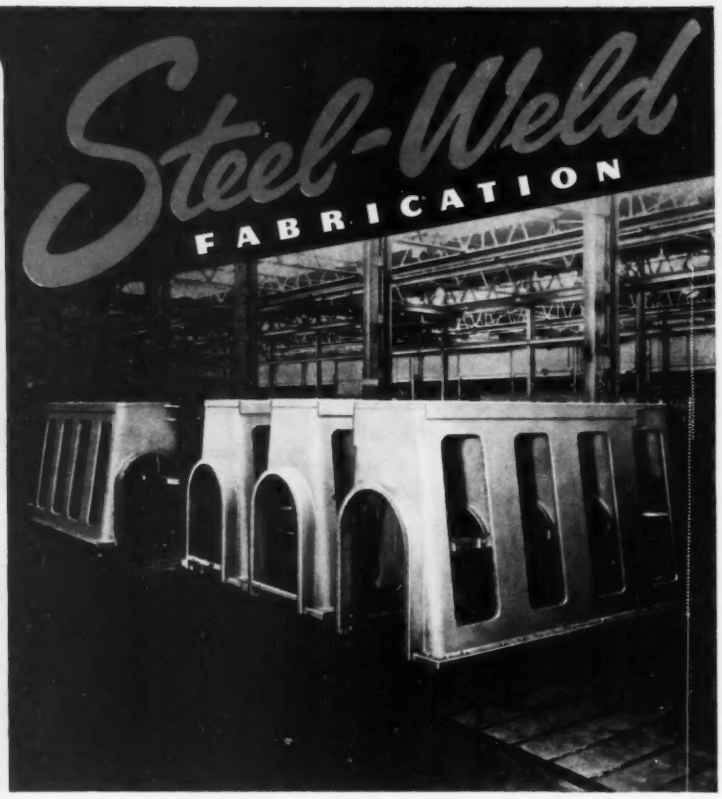
Heavy Press and Machine Frames and Bases for the Machine Tool Industry.



Diesel Engine Crank Cases and Frames for the Marine and Electro-Motive Field.



Crank Cases, Frames, and other Parts for Manufacturers of Marine Steam Engines of Uniflow or Multiple Expansion Type.



Use WELDED STEEL for Greater Strength with Less Weight!

Illustrated above is a group of marine steam engine frames in the machine shop of the Steel-Weld Division in the Mahon plant . . . these and many others similar in design have been Steel-Weld Fabricated and completely machined by Mahon for both diesel and steam marine engine manufacturers throughout the country. If savings in time or production costs can be effected in your manufacturing operations through Steel-Weld Fabrication of parts, assemblies or fixtures, it will pay you to investigate Mahon facilities and technical services. You will find an unique source with complete, modern fabricating, machining and handling facilities to cope with any type of work regardless of size or weight . . . a source where skillful designing and advanced fabricating technique are supplemented by craftsmanship which assures you a smoother, finer appearing job, embodying every advantage of Steel-Weld Fabrication.

THE R. C. MAHON COMPANY
DETROIT 34, MICHIGAN

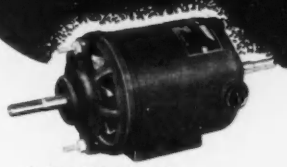
Engineers and Fabricators of Steel in Any Form for Any Purpose

MAHON

Proved IN MANY SERVICES

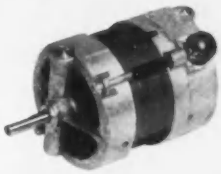
Lamb Electric

SPECIAL APPLICATION
FRACTIONAL HORSEPOWER **MOTORS**



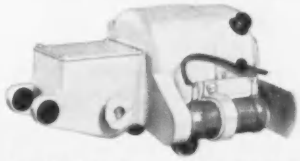
Lightweight universal motor for portable devices requiring a self-ventilated, high-speed motor.

Universal motor parts for portable electric tools, garage equipment and other industrial devices.

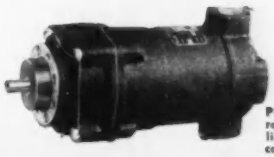


Low weight universal motor with long lubrication life, for home appliances, sirens and many other applications.

Universal motor with shaft carried on double row ball bearings; developed for use as a high-speed grinder.



Series universal motor with inbuilt gear reduction and drive shaft at right angles to armature shaft.



Planetary inbuilt speed reducer permits a straight line drive, symmetrical construction; insures good performance.

Typical of the fields in which Lamb Electric Motors have gained a reputation for outstanding performance, are aircraft components, business machines, industrial and commercial equipment, household appliances, machine tools and portable electric tools.

Back of the good performance of Lamb Electric Motors is the fact that each motor is designed for a particular product or device, thereby insuring exact mechanical and electrical requirements.

In addition to providing dependability, this *special engineering* usually results in savings in space, weight and cost factor.

The Lamb Electric Company • Kent, Ohio.

THEY'RE POWERING
AMERICA'S *Finest* PRODUCTS

Lamb Electric

SPECIAL APPLICATION
FRACTIONAL HORSEPOWER **MOTORS**

QUALITY CONTROLLED

Pheoll

SCREWS, BOLTS, NUTS and SPECIAL FASTENERS

SAVE STOCKROOM TIME

Requisitions to your stockroom for Pheoll Fasteners can be filled in less time. Boxes, kegs and packages are plainly marked with sizes clearly indicated for rapid identification. Pheoll's quality products handle easily, can be quickly counted or transferred to bins or assembly line trucks.

REDUCE ASSEMBLY TIME

Workmen gain time assembling with Pheoll screws, bolts, and nuts because they are accurately threaded, drive easily, seat rapidly, grip tighter—assuring stronger assemblies, easier inspection and less rejects.

IMPROVE YOUR PRODUCT APPEARANCE

The uniform quality of Pheoll Fasteners improves your product appearance. Precision slotted and finished heads, cleanly chamfered nuts, prevent marred surfaces and add to your product's sales appeal. Write for Pheoll literature and price list.

Save Costs... Increase Profits with these Pheoll Fasteners

ASK ABOUT PHEOLL Machine Screws† • Machine Bolts • Special Screws and Bolts • Cap Screws • Machine Screw Nuts • Wood Screws† • Thumb Screws • Brass Washers • Stove Bolts†

†Furnished in slotted and Phillips Recessed Head Types

Pheoll MANUFACTURING COMPANY

5700 ROOSEVELT ROAD
CHICAGO 50, ILLINOIS

SCREWS • BOLTS • NUTS

when timing poses a problem, it's time to consult the **A. W. HAYDON** *company*

Regardless of the intricacies of an application, you can depend on prompt and thorough evaluation by experienced engineers of The A. W. Haydon Company.

From problem statement through quantity production, the specialized know-how of The A. W. Haydon Company is devoted to expeditiously fulfilling your requirements.

WRITE FOR CATALOG

The A. W. HAYDON COMPANY
221 NORTH ELM STREET
WATERBURY 20, CONNECTICUT
Design and Manufacture of Electrical Timing Devices

ALUMINUM EXTRUSIONS

fast deliveries

on A, B, C and E Allotments

Any shape that can be contained in a 6 inch circle. Any length up to 40 feet. Send drawings, specifications and data.

Fabrication facilities available!

We are equipped for aluminum fabrication from extrusion to finished product.

Address Dept. PE-11

MICHAEL FLYNN MANUFACTURING COMPANY

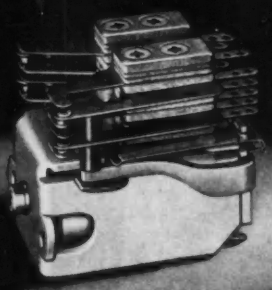
700 East Godfrey Ave., Philadelphia 24, Pa.

Telephone Fidelity 2-5500

THE *New* CLARE TYPE "N" RELAY...

a small, highly sensitive relay designed for efficient operation on low power*

CLARE Type "N" RELAY



CLARE Type "N" Relays are designed for operation on extremely low power. A close-coupled magnetic circuit, generous use of magnetic iron, and unusually efficient coil design give high sensitivity while retaining high contact pressure (minimum 30 grams) and adequate contact gap (minimum 0.015").

Other important advantages include small size, light weight, and especial adaptability to hermetic sealing. Type "N" Relays having not more than 14 terminals for coil and contact springs can be hermetically sealed in enclosures of extremely small size.

For more detailed information on Clare Type "N" Relays you are invited to write for Bulletin No. 109. Clare sales engineers are located in principal cities. Call them or write C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois. In Canada: Canadian Line Materials, Ltd., Toronto 13. Cable Address: CLARELAY.

SPECIFICATIONS of CLARE Type "N" RELAY

COIL
Single- or double-wound. Double wound coils are concentric and have four terminals, two for each winding.

OPERATING VOLTAGE
Up to 160 volts dc.

ARMATURE
Single- or double-arm. Armature has high lever ratio (approx. 3:1) and no air gap.

CONTACT ASSEMBLY
Form: A to C. Maximum of 10 springs per pileup.

CONTACTS
Code No. 4 standard unless load conditions require different contact material.

TERMINALS
All located on armature end of relay.

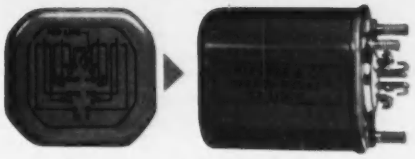
DIMENSIONS
Length: 1⅝". Width: 1⅝". Height: Min. (with two contact springs) 1½"; Max. (with ten contact springs) 1⅞".

NET WEIGHT
Single-arm, 2¾ oz. (approx.); double-arm, 3 oz. (approx.).

MOUNTING
Two #5-40 tapped holes on ⅝" centers. Locate by mounting screws (sizes) from coil.

* With a 10,000-ohm coil, 1 Form C contact (spdt), and a standard adjustment, this relay will operate on less than 50 milliwatts. With a 450-ohm coil and four Form C contacts (4pdt), it will operate on 7/10 watt, even under conditions of vibration and high ambient temperature.

Clare Type "SN" Hermetically Sealed Relay

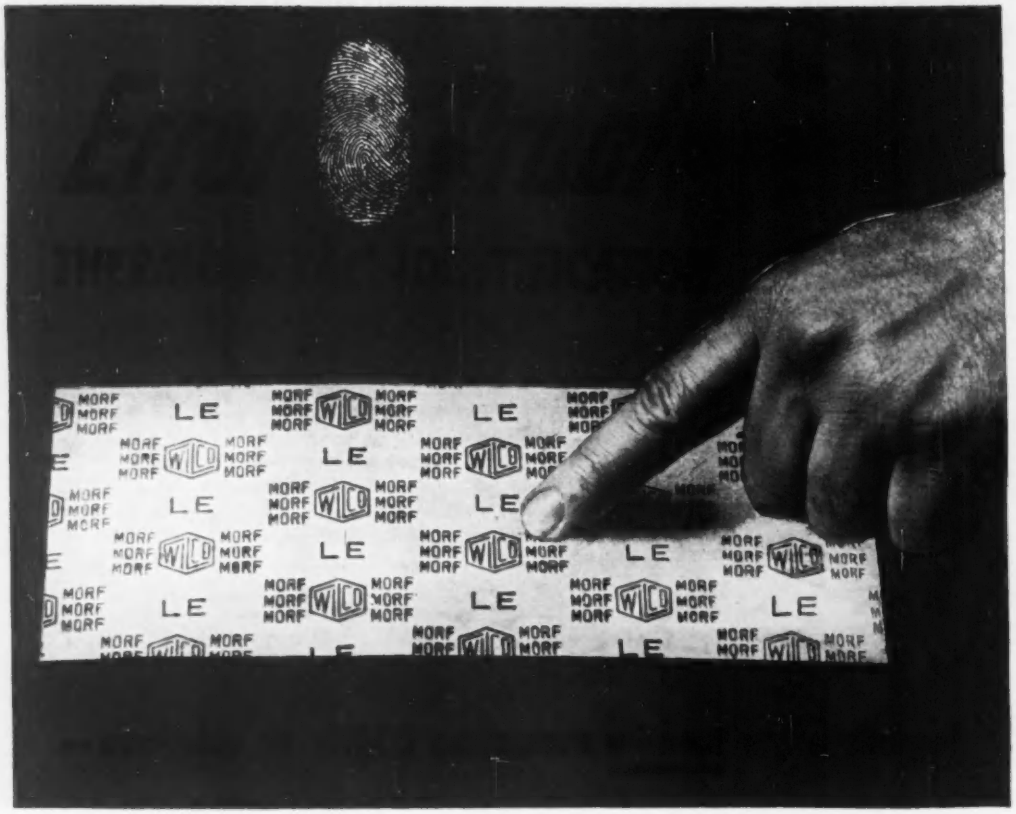


Shown above is one of the hermetically sealed steel enclosures in which the Type "N" Relay can be sealed. Dimensions are: Length: 1-7/16"; Height: 2-1/16"; Width: 1⅝". Net weight of relay having 12 contact springs, six in each pileup, is 5 oz. (approx.). Note connection diagram clearly and permanently imprinted on base of enclosure by silk screen process.

Write for CLARE Bulletin No. 109

CLARE RELAYS

First in the Industrial Field



The H. A. Wilson Company has added to its long list of pioneering achievements a positive method of thermostatic bimetal identification . . . patterns *clearly etched* on every strip of WILCO *Thermometal.*

Result . . . users of these thermostatic bimetals are fully safeguarded against costly assembly errors due to confusing the low expanding with the high expanding side of a strip or one type of thermometal with another.

Instant Identification—*Etched patterns* include *abbreviation* of name of material . . . e.g., "MORF" for "MORFLEX"—also "LE" or "HE" in large characters for identification between the low and high expanding sides.

For added protection . . . repetitions of these patterns cover the entire surface of the strip . . . and replicas of the famous WILCO trademark. These etchings stand out prominently on the smallest piece of Thermometal.

37 Years of Outstanding Service to Customers—Just as the etched patterns safeguard the manufacturing customer against costly mistakes in assembling WILCO Thermometal parts. . . so the quality and precision manufacture of all WILCO products safeguard him against *costly deviations* in any device using WILCO materials. For 37 years, in thousands of applications, American industry has found The H. A. Wilson Company a dependable source of thermostatic bimetal, in sheet or strip, in partly or completely fabricated parts, and in a wide variety of assemblies. The 36 WILCO Thermometals are adaptable to all temperature ranges, deflection rates and electrical resistivities.

WILCO Engineers will gladly cooperate with *you* in securing the most effective use of WILCO products.

WILCO PRODUCTS INCLUDE:

Group one—Thermometal (Thermostatic Bimetals). All temperature ranges, deflection rates and electrical resistivities.

Group two—Electrical Contacts including Silver, Platinum, Tungsten and their alloys . . . Sintered Powder Metals . . . Precious metal laminated collector rings.

Group three—Clad and Overlaid Composite Materials (Strip Stock and Wire) with facings of gold, silver, platinum, copper and nickel bonded to copper, beryllium copper, steel and nickel. Jacketed wire, silver on steel, copper, invar and other combinations. Rolled Gold Plate and gold filled wire.

Group four—Special Alloys, Ni-Span C* Constant Modulus Alloy; other special alloys, including high strength and high conductivity copper base alloys.

***Reg. Trade Mark The International Nickel Co., Inc.**

THE H. A. WILSON COMPANY

105 CHESTNUT STREET, NEWARK 5, N. J.

Branch Offices: **CHICAGO • DETROIT • LOS ANGELES • PROVIDENCE**

SPECIALISTS FOR 37 YEARS IN THE MANUFACTURE OF THERMOMETALS • ELECTRICAL CONTACTS • PRECIOUS BIMETALLIC PRODUCTS AND SPECIAL ALLOYS

MARCINELLE—Plant No. 1

MARCINELLE—Plant No. 2

RUISBROEK

HERSTAL

ACEC

electric motors

are backed by 70 Years' Designing & Engineering Experience plus 4 Modern Plants

Four up-to-the-minute plants, utilizing the accumulated engineering and manufacturing experience of seven generations to produce the finest type electrical equipment, that's ACEC—Ateliers de Constructions Electriques de Charleroi, of Belgium.

And world-famous ACEC motors—from ¾ to 200 hp.—are now *immediately available* to American customers from warehouse stocks in the United States.

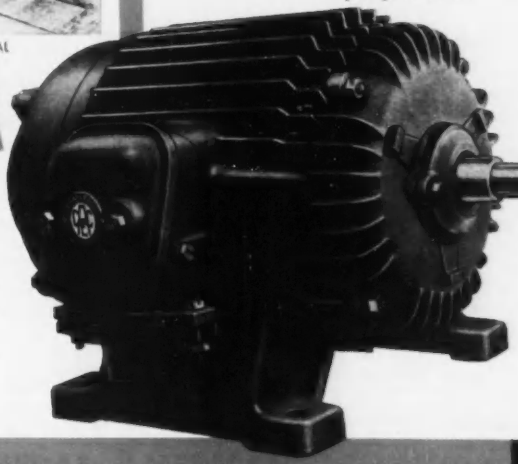
Conforming strictly to NEMA FRAMES AND SPECIFICATIONS, these 1-phase and 3-phase motors are not only products of long experience and scientific research, but of extreme care in manufacture and close attention to mechanical precision. They are built to give every possible satisfaction in service . . . to uphold the world-wide reputation for excellence that ACEC equipment has established.

Branches and representatives of ACEC are located throughout 50 countries, and service in the United States is available from 232 DISTRIBUTORS AND SERVICE SHOPS across the nation.

Whatever your electric motor requirements, write, wire, or telephone the nearest ACEC office or representative—or communicate with us directly in New York. Inquiries and orders receive prompt attention.

IMMEDIATE DELIVERY

from
NEW YORK
CHICAGO
KANSAS CITY
NEW ORLEANS
DALLAS AND
LOS ANGELES
Warehouses



NOW ON HAND

Integral Horsepower Electric Motors—
¾ to 200 hp.
FULLY GUARANTEED

Available in the following types:

- ★ *Open Drip Proof Motors*
- ★ *Totally Enclosed Fan Cooled Motors*
- ★ *Pump Motors:*
  Style "C" Face Mounted
  Style "P" Vertical Solid Shaft
  Vertical Hollow Shaft
- ★ *Adjustable Speed Schrage Motors*

MOTORS EXCEEDING 200 HP. BUILT TO ORDER

BELGIAN ELECTRIC SALES CORPORATION

Main Office: One E. 53rd St., New York 22, N.Y. • Tel.: Plaza 8-3105

Branches and Representatives in

Los Angeles • Dallas • Chicago • Kansas City
San Francisco • New Orleans • Pittsburgh • Louisville • Hammond
Savannah • Youngstown • Washington, D.C. • Puerto Rico

Sole representatives of
ATELIERS DE
CONSTRUCTIONS
ELECTRIQUES de CHARLEROI

CHARLEROI ACEC

Electrical Engineers and Manufacturers

See General American for plastics facilities unmatched...anywhere!

Make General American your complete molding source for *defense* and *civilian* production. Use most modern production-line equipment available . . . *facilities unmatched* anywhere in scope and versatility. Take advantage of skilled personnel . . . engineers, die-makers, set-up men. Ask to see samples of General American's experience with hundreds of different plastics applications . . . which have speeded production and bettered products in many industries. Write us about *your* problem . . . we'd like to help you.

PLASTICS DIVISION GENERAL AMERICAN TRADE MARK

LOW PRESSURE MOLDING
48" x 144" low pressure molding of reinforced plastics . . . supplemented by smaller presses.

TOOL AND DIE SHOP
General American maintains one of the most extensively equipped and modern shops in the country. Completely mechanized.

IN ADDITION . . .
General American offers high speed Logoquant-treating and painting . . . plus a complete assembly and packing service.

MORE MEN AND MACHINES TO PRODUCE YOUR PRODUCTS BETTER

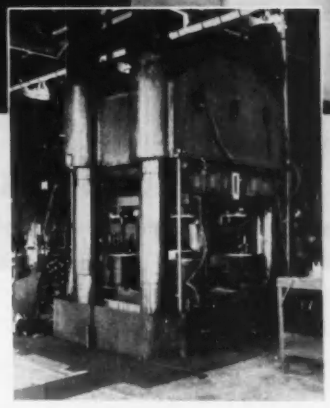
PLASTICS DIVISION • GENERAL AMERICAN TRANSPORTATION CORPORATION

HIGH-SPEED INJECTION MOLDING

Injection equipment at General American includes largest machines ever built.

An overhead crane supplies material. Continuous conveyors carry away finished products.

1—2 oz. machine	(either Acetate or Polystyrene)
3—8-oz. machines	5—48 oz. for Polystyrene
2—16 oz. machines	or 60 oz. for Acetate
10—22 oz. machines	2—85 oz. machines
4—32 oz. machines	(either Acetate or Polystyrene)
(either Acetate or Polystyrene)	1—300 oz. machine
4—48 oz. machines	(either Acetate or Polystyrene)



MULTI-CAVITY COMPRESSION MOLDING
up to 71″ x 74″ platen areas

General American compression presses have turned out some of the largest plastics pieces ever produced.

3—2000 ton presses	2—1000 ton presses
1—1400 ton press	4— 500 ton presses
1—1200 ton press	10— 350 ton presses
6—100 ton presses	

GENERAL AMERICAN TRANSPORTATION CORPORATION

135 S. La Salle Street • Chicago 90, Illinois • New York 17, 10 E. 49th Street • Detroit 2, 2842 W. Grand Blvd.

Cohrlastic

resists temperatures from -100 to +500° F

Silicone rubber-coated fiberglas fabrics for gaskets, seals, ducts, electrical insulation, etc.

Silicone rubber extrusions of various sizes and cross-sections to prints for seals and tubings.

Silicone rubber sheets, solid and sponge, of various thicknesses, for gaskets, seals, vibration dampers, etc.

Silicone rubber molded parts to customers' prints and specifications for resiliency under extreme temperatures.

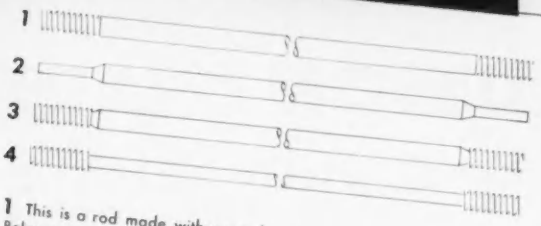
Silicone rubber vibration dampers for instruments and other small sensitive apparatus

Silicone rubber heater elements, light and thin for de-icing or warm-up applications.

Write for technical data sheets or further information on the engineering of Cohrlastic Silicone Rubber into your components

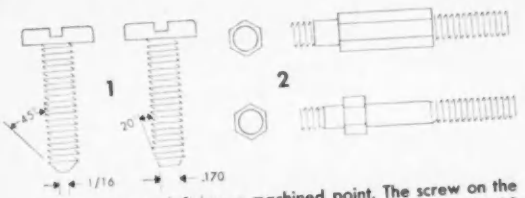
THE *Connecticut* HARD RUBBER COMPANY 411 East Street, New Haven, Conn.

Save Money



1 This is a rod made with a cut thread on each end of $\frac{1}{4}$" wire. Below are examples of how same rod can be made for less money.
2 Shows rod of $\frac{1}{4}$" wire with ends extruded ready for threads to be rolled.
3 Same rod as shown in Sketch #2 after threads have been rolled. Diameter of the threaded sections and unthreaded section are the same as shown in Sketch #1. The rolled threads are stronger than the cut threads.
4 Biggest saving would be made by using, in this case, a rod of .214/.216 diameter with threads rolled on each end. This would result in a savings of $30 per thousand over rod shown on Sketch #1. The tensile strength of the rod is determined by the thread, therefor the tensile strength of the rod is comparable to the other.

Save Time



1 The screw at left has a machined point. The screw on the right has a cold headed point which would save up to $4.00 per thousand. Note the slight difference in the taper of the point and diameter which in many applications would make little difference.
2 The top sketch shows a stud machined out of hex bar with resulting waste of steel and machine time. The bottom sketch shows a design which was upset and threaded, with considerable savings in steel and time resulting in a large saving to the customer.

Save Steel

1 Bolt has a machined point and cut threads. These operations are comparatively expensive.
2 The same bolt made with extruded end and rolled point. Diameter is reduced to permit thread to be rolled to same diameter as shank.
3 Completed bolt with rolled thread. Can be produced faster and at lower cost than bolt shown in Sketch #1.

HOW TO DESIGN SMALL PARTS

to save time—material

and as much as $30.00 per M

How a slight change in design saves time, material and reduces cost of small parts and fasteners is demonstrated by these examples. You may find that many such items you are using now in quantity could be redesigned to save you from $4.00 to $30.00 per thousand without impairing the efficiency of the part in any way. In fact, many parts are improved in strength by cold-heading. Also, the process is fast, lends itself to mass production and conserves critical material.

As specialists in cold heading, Townsend engineers help manufacturers in all industry reduce the cost and improve the efficiency of their parts and fasteners. They may be made of carbon steel, alloy steels, bronze, copper, monel and aluminum. These are supplied in a variety of platings and finishes. If you want to learn more about how you can improve your product and at the same time reduce costs send us a sample or sketch of the item and we will give you a suggestion.

Townsend

COMPANY • ESTABLISHED 1816

Plants: New Brighton, Pa. · Chicago 38, Ill.

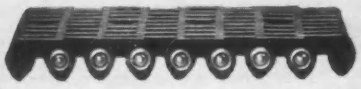
Cherry Rivet Company Division, Los Angeles, California

Sales Offices in Principal Cities

Wherever You are...

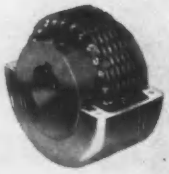
UNION CHAIN
is at your service

UNION ROLLER CHAIN



UNION SILENT CHAIN

UNION
ROLLER CHAIN
FLEXIBLE COUPLINGS



UNION
SILENT CHAIN
FLEXIBLE COUPLINGS

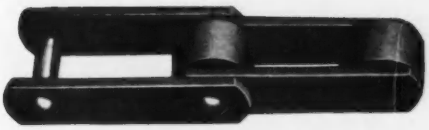
Suppose You Need a UNION Heavy Duty Chain

. . . for a drive or conveying application where heavy loads, slower speeds, long life and moderate cost are factors. Union Chain manufactures a complete line of these heavier types of chains, sprockets, flights and aprons, in addition to roller chain and silent chain, and is therefore in a position to make competent, unprejudiced chain recommendations.

Furthermore, an important phase of Union's service to its customers is the designing and building of special chains for unusual applications, particularly for conveying and elevating. Union is in an unusually fortunate position to render such service since we manufacture steel chains of all types and nothing else. This specialization has given us an unusual insight into problems of power transmission and conveying which our customers find valuable to them.

Perhaps we can be of help to you. Your inquiry will be welcomed.

TYPICAL UNION DRIVE AND CONVEYING CHAINS



HB STRAIGHT SIDE BAR ROLLER CHAIN

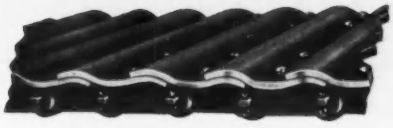
BRIDGE CHAIN

BP CHAIN

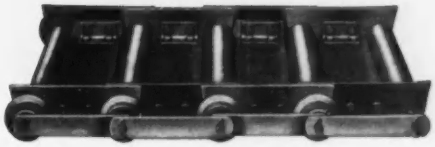
BP ICE CHAIN

HB STRAIGHT SIDE BAR BUSHING CHAIN

COMBINATION MALLEABLE IRON AND STEEL CHAIN



APRON CONVEYOR STYLE A



APRON CONVEYOR STYLE B

UNION CHAIN REPRESENTATIVES

CALIFORNIA
American Chain & Gear Co.
C. A. Nicholas
5511 Pacific Blvd.
Huntington Park, California

GEORGIA
H. F. Edge
208 Walton Bldg.
Atlanta, Georgia

ILLINOIS
Union Chain & Mfg. Co.
W. Albrecht
A. C. Mello
S. Nielsen
Room 1232
53 W. Jackson Blvd.
Chicago, Illinois

INDIANA
Paul W. Huddleston
5745 Guilford Ave.
Indianapolis 20, Indiana

LOUISIANA
F. N. Johnston Co.
2207 American Bank Bldg.
New Orleans, Louisiana

MASSACHUSETTS
Transmission Engineering Co.
Stanley Johnson
6 Hartford St.
Newton Highlands 61, Mass.

MICHIGAN
Union Chain & Mfg. Co.
W. J. White
Bassa Bldg.
7338 Woodward Ave.
Detroit 2, Michigan

MINNESOTA
F. H. Bathke
490 N. Snelling Ave.
St. Paul, Minnesota

MISSOURI
J. B. Flaherty
5473 Delmar Blvd., Rm 206
St. Louis, Missouri

Ed Schiefelbein
311 West 10th St.
Kansas City 6, Missouri

NEW YORK
John B. Foley
107 Tully St.
Syracuse, New York

Mayo & Gleason, Inc.
50 Church St.
New York 7, New York

Potter & Dugan, Inc.
79 Wilkeson St.
Buffalo, New York

NORTH CAROLINA
M. R. Snyder Co.
304 E. Tremont Ave.
P. O. Box 3341
Charlotte 3, N. Carolina

OHIO
Fred W. Barrow
203 Garrard St.
Covington, Kentucky

Union Chain & Mfg. Co.
J. H. Dalrymple
F. Smiley
Marshall Bldg.
Cleveland 13, Ohio

OREGON
J. W. Minder Chain & Gear Co.
3111 S. E. Hawthorne Blvd.
Portland 14, Oregon

PENNSYLVANIA
David Davies
P. O. Box 4
Plymouth, Pennsylvania

Wayne Ritter
3021 W. Liberty Ave.
Pittsburgh 16, Pennsylvania

Union Chain & Mfg. Co.
John A. Shumaker
Room 521
Schaff Bldg.
Philadelphia 2, Pennsylvania

TEXAS
Union Chain & Mfg. Co.
J. H. Castleberry
E. T. Teal
205 Irwin-Keasler Bldg.
Dallas 1, Texas

VIRGINIA
C. Arthur Weaver Co.
403 E. Franklin St.
Richmond 19, Virginia

WISCONSIN
Union Chain & Mfg. Co.
Room 308
Wisconsin Tower Bldg.
606 W. Wisconsin Ave.
Milwaukee 2, Wisconsin

SPECIAL Representatives

NEW YORK
Frank L. Allen, Inc.
50 Church Street
New York 7, New York

E. P. Gahan
500 Fifth Ave.
New York, New York

OREGON
W. D. Hollingworth
Room 400 Concord Bldg.
208 S. W. Stark St.
Portland 4, Oregon

FOREIGN Representatives

ARGENTINA
Stevens & Villatoux, S. R. L.
Muneca 110
Casilla Correos 10
Tucuman, Argentina

CUBA
Central Machine & Trading Co., S.A.
Lamparilla 208
Havana, Cuba

FOREIGN Representatives

GUATEMALA
R. C. Willemsen
Apartado No. 130
4a Avenida Sur No. 20
Guatemala, Guatemala

HAWAII
P. S. Pell & Co., Ltd.
88 S. Queen Street
P. O. Box 1441
Honolulu, T. Hawaii

MEXICO
Thomas M. Nevin y Cia. S.A.
Av. Insurgentes 240
Mexico 6, D. F., Mexico

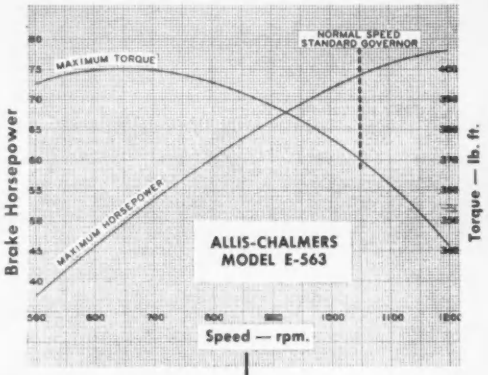
PHILIPPINES
The Edward J. Nell Co.
1450 Arlegui St.
P. O. Box 612
Manila, Philippines

PUERTO RICO
Manuel, Pales, Jr.
Edificio Maritima
Puerta de Tierra
P. O. Box 2969
San Juan 13, Puerto Rico

SOUTH AFRICA
Robins Conveyors (South Africa) Ltd.
Sankey House
Cor. Troye & Marshall Sts.
P. O. Box 4736
Johannesburg, S. Africa

The Union Chain and Manufacturing Company Sandusky, Ohio, U.S.A.

TRANSMIT POWER
UNION CHAINS
CONVEY MATERIALS



GRAPHIC PROOF

that A-C Power Units are Tailor-made for Crushing, Hoisting, other Sudden Overload Jobs

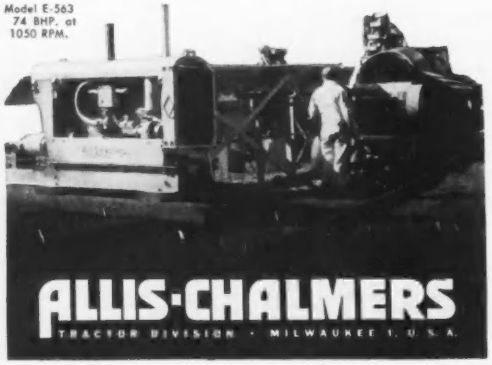
HIGH TORQUE CHARACTERISTICS — Above curve shows how A-C engines build up necessary torque quickly even when throttled way down handle the sudden overloads so common to crushing and allied service.

SUPER-SENSITIVE GOVERNOR — helps lick overloads before they get started. One crusher operator's comment: "That A-C engine seems to 'see' big rocks topple in . . . it's all ready when they hit the jaws."

REAL DUST PROTECTION — Oil bath type air cleaners are standard on Allis-Chalmers power units, as well as fuel and lube oil filters. In addition, oil seals protect crankshaft; water pump is self-sealing.

MEDIUM SPEED, HEAVY-DUTY DESIGN — assures steady flow of power, extra long life at lowest cost. You also save on first cost because these engines are mass-produced along with tractor engines by the thousands.

A-C power units operate economically on gasoline, natural gas or low grade fuel, and there are accessories to fit a wide variety of applications. Our power engineers will gladly help you select the proper unit for your job.



FOR FINER APPEARANCE, PERMANENT READABILITY

Identify your products with metal name plates by

CHICAGO THRIFT-ETCHING CORPORATION

We'll gladly quote, without obligation to you, on your requirements for name plates, instruction plates, dials, panels, scales, etc. We are equipped also to apply special finishes to aluminum products and parts, including ANODIZING by the exclusive Alumilite process. Write today for detailed information and quotations.

CHICAGO THRIFT-ETCHING CORPORATION
1555 North Sheffield Avenue, Chicago 22, Ill., Dept. B
SUBSIDIARY OF DODGE MFG. CORPORATION, MISHAWAKA, IND.

Welding Machine Manufacturer Specifies CASH-ACME

Type "B" Pressure Reducing and Regulating Valve

Where two or three stage high pressure reduction is required, a combination of CASH-ACME Automatic Pressure Reducing and Regulating Valves can be depended upon to do the job. Consistent, unfailing operation due to precision construction of the finest quality materials is the reason CASH-ACME Valves are being specified by more and more industries. Write for literature describing CASH-ACME Automatic Valves and the pressure control job they can do on your products.

CASH ACME SILENT SENTINEL Automatic Valves

A. W. CASH VALVE MANUFACTURING CORP.
6663 E. Wabash Avenue
Decatur, Illinois

SLEEVE BEARINGS
•
CAST BRONZE BUSHINGS
•
ROLLED, SPLIT BUSHINGS
•
PRECISION BRONZE PARTS
•
WASHERS
•
SPACER TUBES
We specialize in the production of sleeve bearings and parts with bearing properties.
Within our six-plant manufacturing organization, our products range from simple spacer tubes to big, precision bearings weighing hundreds of pounds each. We work with babbitt, copper-lead, bronze, steel, brass, aluminum or silver—in standard or special alloys to meet exact specifications.
All production rigidly quality-controlled. Research and engineering facilities available without obligation. FEDERAL-MOGUL CORPORATION, 11043 Shoemaker, DETROIT 13, MICHIGAN
Since 1899
FEDERAL-MOGUL

HERE'S PROOF

FAST'S COUPLINGS cost you less to own and operate

ON BILLET MILL SINCE 1923

ON GAS BLOWER SINCE 1920

ON AMMONIA COMPRESSORS SINCE 1922

Fast's Couplings cost you less per year because they normally outlast the equipment they connect. That means their reasonable cost can be spread out over 20 years or more . . . assuring low-cost service without excessive maintenance costs!

Fast's basic design is *foolproof!* Instead of a perishable oil seal, Fast's are the only couplings to use a *permanent* metal-to-metal closure. Oil is always maintained at a safe level . . . whether the coupling is running or standing still . . . and dirt cannot get in. Fast's Couplings are compact, yet large enough to stand up under punishing service for 20 years or more!

When you specify Fast's Couplings, you get Koppers' valuable engineering service. In many cases where a special coupling appears necessary, Koppers engineers can modify a standard Fast's and save you money! Get the facts on Fast's Couplings. Mail the coupon for your copy of Fast's *free* Catalog today!

Mail Coupon for FREE Catalog

KOPPERS CO., INC., Fast's Coupling Dept.,
331 Scott Street, Baltimore 3, Md.

Gentlemen: Send me Fast's Catalog which gives detailed descriptions, engineering drawings, capacity tables and photographs.

Name.....

Company.....

Address.....

City.....Zone.....State.....

KOPPERS

FAST'S

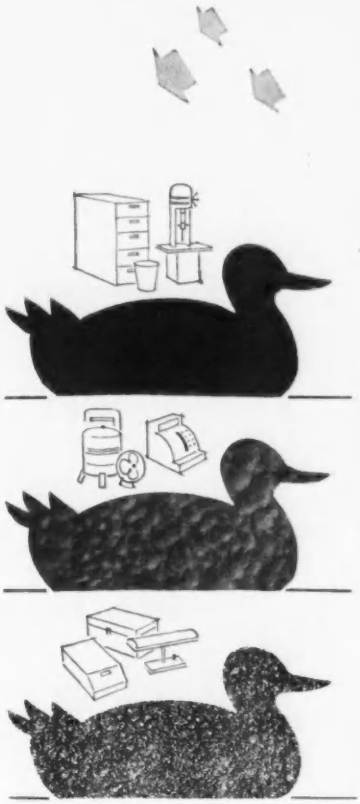
THE ORIGINAL GEAR-TYPE

Couplings

INDUSTRY'S STANDARD FOR 31 YEARS

SPRUCE UP

"UGLY DUCKLING" PRODUCTS WITH ONE OF THESE THREE S·W "GLAMOUR FINISHES"!



Don't let "hard-to-dress-up" surfaces limit your product's usefulness or sales appeal! One or more of these unique and practical Sherwin-Williams special finishes can give it glamour . . . richness . . . added sales appeal . . . can be adapted easily to your finishing line requirements. Ask for full details on the finishes best adapted to your needs! The Sherwin-Williams Co., General Industrial Division, Cleveland 1, Ohio.

1. DIMENSO "HAMMERED" FINISHES

This exclusive S-W finish is a multichromatic organic that can be applied to any metal or wood surface with a special gun that sprays two colors in a single operation. *Dimenso* bakes quickly to a tough, smooth, durable film of exceptional brilliance. It imparts deep, lasting color, full of life and sparkle and with infinite shadings of tone. It gives realistic, 3-dimensional hammered and spot effects in toned or diffused patterns.

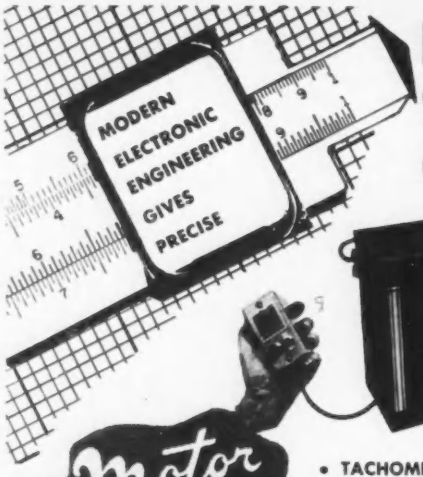
2. DIMENSO ONE-COAT METALLIC

Dimenso One-Coat Metallic offers a high-quality hammered finish at moderate cost with standard spray equipment and a single material. It produces a striking, deep-toned hammer pattern and air dries or bakes to a tough, durable film. By a slight change in method, it is possible to produce an opalescent finish in addition to the hammer finish with identical film characteristics. Available in Silver, Blue, Green and Tan.

3. KEM ART METAL

With this line of durable and distinctive nonmetallic wrinkle finishes, highly decorative effects are possible on a wide variety of products. These finishes are applied with conventional spray equipment and fit into any baking schedules, including extremely fast infrared. The film looks thick and tough—actually is—but, at the same time, it has a velvety appearance which is appealing and restful.

SHERWIN-WILLIAMS
INDUSTRIAL FINISHES



FINGERTIP SPEED CONTROL

Motor Control

- TACHOMETER PROPORTIONING
- TENSION OR POSITION CONTROL
- MOTOR INTEGRATORS
- BI-DIRECTIONAL
- DYNAMIC BRAKING
- SERVO CONTROL

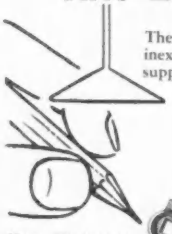
Servo-Tek products co.
4 Godwin Ave. Paterson, N. J.

WARNING Sparton HELPS MAKE IT SURE

WITH . . .

GRC

TINY ZINC DIE CASTINGS



The Sparks-Withington Company found small inexpensive GRC zinc die castings made ideal supporting bracket spacers for their Sparton air-shell horns. Whatever you manufacture—warning signals, bazookas or electronics equipment—it will pay you to consider the speed and economy of die casting for your small metal parts. Gries' exclusive facilities turn out simple or intricate parts in one automatic operation — completely trimmed, ready for use. 100,000 pieces to many millions.

Max'm. Weight ½ oz.
Max'm. Length 1¾ in.
SMALLNESS UNLIMITED

Write today for bulletin and samples.

GRIES REPRODUCER CORP.

98 Willow Ave., New York 54 • Phone: MOtt Haven 5-7400

TAP-LOK INSERTS

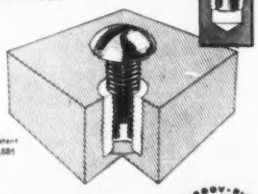
prevent thread stripping in soft materials

The unique self-tapping feature of TAP-LOK INSERTS substantially reduces assembly costs in continuous production, by eliminating a separate tapping operation. This method of increasing the shear area of tapped threads in softer-than-steel materials is fast and economical, consisting of three easy steps:

① A simple driving tool with a threaded stud engages the interior threads of the insert until its shoulder contacts the top of the insert.

② The driving tool then turns the insert into a cored or drilled hole equal in size to a tap drill hole for the insert's external thread. The insert cuts its own thread.

③ After the insert is seated, the male threaded member is driven into the interior thread of the insert.



U. S. Patent 2,455,881

Send for samples and descriptive folder.

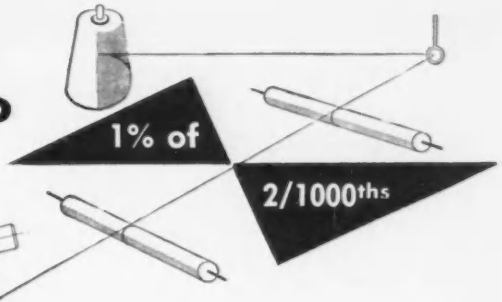
Also manufacturers of Groov-Pins for positive locking press fit.

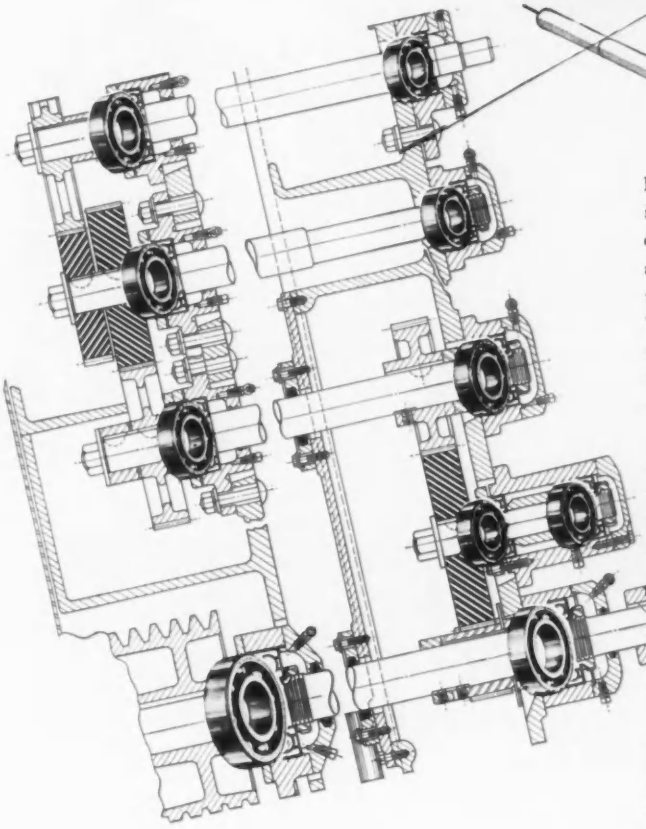
GROOV-PIN

GROOV-PIN CORPORATION

1121 HENDRICKS CAUSEWAY
RIDGEFIELD, NEW JERSEY

SETUP
that holds tolerance to





Bearings used
Fafnir Extra-Precision Ball Bearings of the 200 (Light) and 300 (Medium) Series are shown in the ten locations above.

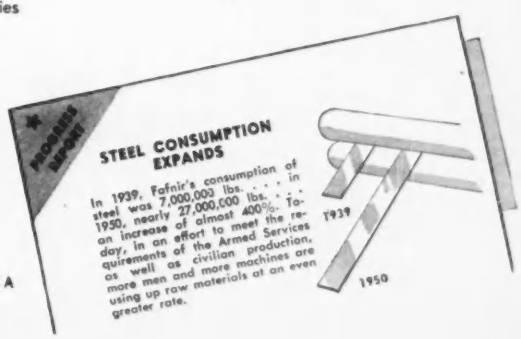
If you are familiar with machine designing, you'll consider this a "neat" piece of engineering. Such precision is actually achieved on mammoth synthetic thread twisters developed by Whitin Machine Works. The twisters stretch thread to a uniform .002 of an inch diameter and hold that diameter to within a 1% tolerance down a 40 foot line of spindles.

A sectional view of the head end which controls the "feed rolls" and "draw rolls" shows the Fafnir Ball Bearing setup that helps to keep their relative velocity absolutely constant . . . a "must" to produce such an amazing degree of accuracy. The Extra-Precision ball bearings used are made by highly trained operators on special equipment controlled by elaborate inspection devices.

Whatever your bearing problem, a few minutes spent with a Fafnir representative may help you solve it equally as successfully. Fafnir's experience is not limited to just a few industries . . . it's industry-wide. The Fafnir Bearing Company, New Britain, Conn.

FAFNIR
BALL BEARINGS

MOST COMPLETE LINE IN AMERICA


PROGRESS REPORT
STEEL CONSUMPTION EXPANDS
In 1939, Fafnir's consumption of steel was 7,000,000 lbs. . . . in 1950, nearly 27,000,000 lbs. . . . an increase of almost 400%. Today, in an effort to meet the requirements of the Armed Services as well as civilian production, more men and more machines are using up raw materials at an even greater rate.
1939
1950

IF YOUR PRODUCT

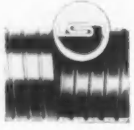
INHALES

or EXHALES

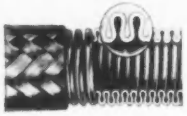
This grain loader manufactured by Dunbar Kopple, Inc. Geneva, Ill., utilizes interlocked flexible metal hose for sucking up grain from trucks, bins, etc.

Corrugated metal hose is used for the exhaust line in this diesel-electric generator set manufactured by D. W. Onan & Sons, Inc., Minneapolis.

it will give better service if it's equipped with CMH Flexible Metal Hose



REX-TUBE convoluted hose is available in a variety of types including square locked, ball bearing and fully interlocked in a variety of metals including steel, bronze and other alloys.



REX-WELD corrugated steel and bronze hose is available in standard sizes from 3/16" through 12" I.D. for burst pressures to 12,000 psi, temperatures to 1000° F. Stainless steel types also available.

Wherever movement is required, liquids, gases or granular solids can be conveyed efficiently with CMH Flexible Metal Hose. Vibration, misalignment or expansion and contraction can be handled economically. CMH Flexible Metal Hose combines the durability and long life of metal . . . and contributes to the good performance of a wide range of products.

The new CMH catalog of flexible metal hose products for product designers is just off press. Be sure and write for your copy.

Flexon identifies CMH products that have served industry for over 49 years.

CHICAGO METAL HOSE Corporation

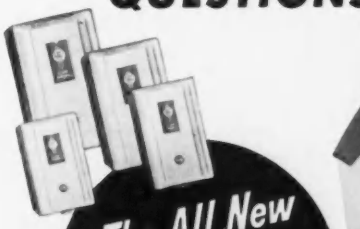
1351 S. Third Ave. • Maywood, Ill. • Plants at Maywood, Elgin, Rock Falls, and Savanna, Ill.
In Canada: Canadian Metal Hose Co., Ltd., Brampton, Ont.

CMH

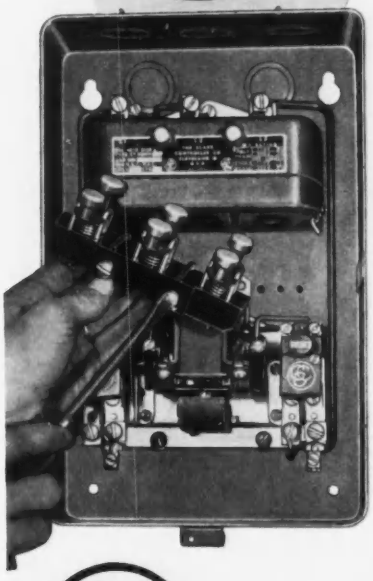
ONE DEPENDABLE SOURCE
for every flexible metal hose requirement

Convoluted and Corrugated Flexible Metal Hose in a Variety of Metals • Expansion Joints for Piping Systems
Stainless Steel and Brass Bellows • Flexible Metal Conduit and Armor • Assemblies of These Components

Here are the ANSWERS to your AC MOTOR STARTER QUESTIONS



The All New CLARK TYPE "CY"



Question: What makes a GOOD Motor Starter?

Answer: Dependability in operation . . . ruggedly built for hard usage . . . long life . . . requiring little attention . . . easy inspection and maintenance.

Question: What makes the new CLARK Type "CY" different?

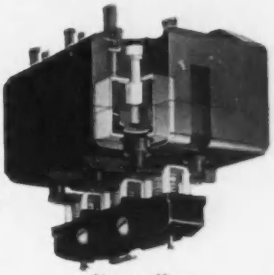
Answer: An entirely new, advanced principle of arc interruption; combining strong, multi-turn magnetic blowouts and twin-break contacts.

Question: How does this improve its operation?

Answer: Constant forced rotation of the arc—moving continuously from a hot to a cold spot, minimizes burning or pitting of contacts.

Question: How about maintenance?

Answer: Longer contact life means less service. No filing, dressing or cleaning of contacts required. No tools necessary to inspect contacts. Contacts, coils and other components easily changed. The CLARK Type "CY" is the maintenance man's dream!



Phantom View Showing Arc Shield

Question: Is it rugged?

Answer: Mill Type heavy-duty construction and design provide extra protection and dependable operation in severe service.

Question: Any other advantages?

Answer: Many—among them the ingenious design of the solid upper arc shield that prevents accumulation of hot gases between wiring terminals, minimizing phase-to-phase failures.

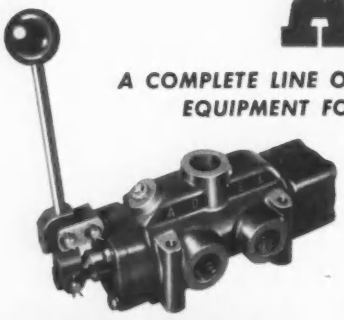
Let a CLARK application engineer show you what this new line of CLARK Type "CY" Starters means to you in increased production and lower maintenance.

THE CLARK CONTROLLER CO.

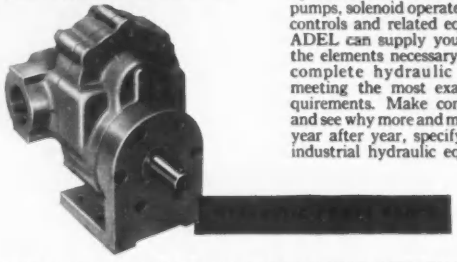
ENGINEERED ELECTRICAL CONTROL • 1142 EAST 152ND STREET, CLEVELAND 10, OHIO

ADEL

A COMPLETE LINE OF INDUSTRIAL HYDRAULIC EQUIPMENT FOR EVERY APPLICATION



For fourteen years ADEL has continuously directed its energies to the advanced development and production of high-quality hydraulic equipment. With the most modern facilities in our 150,000 square foot plant, we build ruggedness, efficiency and compactness into each ADEL unit. The variety of equipment being manufactured has been steadily expanded until today it encompasses a complete line of hydraulic control valves, power pumps, solenoid operated remote controls and related equipment. ADEL can supply you with all the elements necessary to build complete hydraulic systems meeting the most exacting requirements. Make comparisons and see why more and more users, year after year, specify ADEL industrial hydraulic equipment.



A FEW SELECT TERRITORIES ARE STILL AVAILABLE TO PROGRESSIVE DISTRIBUTORS OF HYDRAULIC EQUIPMENT. INQUIRIES INVITED.

Write for Bulletins
ADEL DIVISION
OF GENERAL METALS
CORPORATION,
10767 Van Owen St.,
Burbank, California

ADEL LEADER IN HYDRAULICS

DIVISION OF GENERAL ...PORATION • Burbank, Calif.

Manufacturers of Industrial Hydraulic Valves and Pumps

DISTRIBUTORS: AIR & HYDRAULIC CO., NEW HAVEN, CONN. • RUSS CHAMBERLIN COMPANY, PORTLAND, OREGON • J. BOYD COATES, PHILADELPHIA, PA. • FRANK T. DONNELLY COMPANY, PITTSBURGH, PA. HASKEL ENGINEERING & SUPPLY CO., SAN FRANCISCO, CALIF. • HASKEL ENGINEERING & SUPPLY CO., GLENDALE, CALIF. • HYDRAULIC BRAKE SUPPLY CO., PHOENIX, ARIZ. • LINCOLN SUPPLY CO., PROVIDENCE, R. I. • SCOTT EQUIPMENT AND ENGINEERING COMPANY, DAYTON, OHIO • H. F. SODERLING CO., SEATTLE, WASH. • ROBERT TAYLOR & SONS, SALT LAKE CITY, UTAH • WYATT SALES COMPANY, CLEVELAND, OHIO • CORBY SUPPLY COMPANY, ST. LOUIS, MO. • INDUSTRIAL AIR & HYDRAULIC EQUIPMENT CO., DETROIT, MICH. • HYDRAQUIP CORPORATION, HOUSTON, TEX.

If joints in your product call for a liquid cement— you need fast-setting

AMBROID

ORDER TODAY

and TAKE ADVANTAGE OF

- ....faster ultimate joint-strength
- ....high tensile strength
- ....high flexural qualities
- ....good resistance to impact
- ....stability over wide temperature range
- ....high moisture resistance
- ....high dielectric qualities
- ....ready to use
- ....transparent

AMBROID has everything you need in a fast drying, transparent non-toxic liquid adhesive. Immediate shipment—packaged in 2 oz and 4½ oz tubes, pints, quarts and one gallon cans, drums. Write for data sheet.

AMBROID CO.

304 Franklin Street

Boston 10, Mass. U. S. A.

Send Us Your GASKET PROBLEMS

Vellumoid's wide variety of non-metallic gasket materials and its nearly half-century experience have helped solve many a gasket problem.

Samples for testing purposes gladly sent on request.

VELLUMOID
444 VELLUMOID
VELBESTOS
(Compressed Asbestos)
VELLUTEX
VELBUNA
THIOKOL & BUNA N Coated Materials

THE VELLUMOID CO.
Worcester (6) : Mass.

SEVERAL OPERATIONS SAVED
by rolling this shape
Maybe the section you want to sub-contract doesn't look like this one but . . . the same economies will apply. The section illustrated demonstrates our lower cost story. Punching, notching, roll forming and cutting to length of this specific piece are done in one continuous operation. As a designer or production man, you know how the saving of operations lowers the unit cost. Continuous rolling saves man hours, eliminates extra handling of parts, and improves uniformity and accuracy.
How about your part?
We have the equipment in our modern plant to turn out your parts by the thousands or millions on a good delivery schedule. Why not try Roll Formed Products on your next requirement? Send us prints or parts for prompt quotation. If you would like to know more about us, write for our brochure with the whole story.
ROLL FORMED PRODUCTS
COMPANY
MAIN OFFICE AND PLANT
3760 OAKWOOD AVE. · YOUNGSTOWN, OHIO

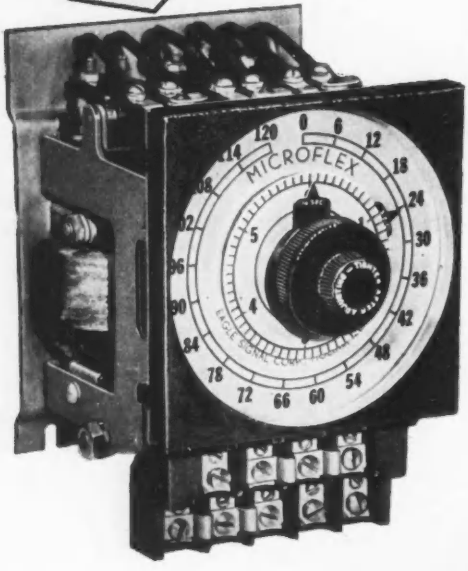
TIMING INCREASES PRODUCTION!

Measure it Automatically!

You can increase production and save many man-hours with the right precision Timer.

There is an Eagle Timer designed for your industrial problem.

Write Eagle Signal or see your nearest representative for an answer to your timing problem.



MICROFLEX
RESET TIMER

The MICROFLEX is a precision Timer, designed with a choice of over 100 Timer operating combinations to fit your industrial process. Large easy-to-read dial with Micrometer type knob for accurate, fast settings. Precision built for continued precise operation.

Write for Bulletin 110 and see how this Timer can increase accuracy and speed up production in your plant.

Dials Available: 0.3 seconds—120 seconds
3 seconds—20 minutes
18 seconds—120 minutes
3 minutes—20 hours

Export Agent:
13 EAST 40th ST., NEW YORK 16, N. Y.

EAGLE SIGNAL
Industrial Timers
EAGLE SIGNAL CORPORATION MOLINE, ILL.

Proved Performers

Packard

FRACTIONAL HORSEPOWER MOTORS

Increased value for your product and customer good will are plus values that follow naturally when you specify Packard fractional horsepower motors. *Packard's outstanding performance record is known and respected everywhere.* Thirty-five years' experience, concentrating on the manufacture of fractional horsepower motors alone, has built an exceptional reputation for Packard. And today—with newly expanded facilities for both engineering and manufacturing—Packard continues to concentrate on this one important field.

All the skill and know-how that Packard has accumulated, all the facilities at our command, and all the prestige Packard Electric Motors can lend to your product are yours when you specify Packard. *Packard fractional horsepower motors are proved performers, approved in advance by your customers.*

PACKARD ELECTRIC MOTORS for
Washing Machines • Ironers • Driers • Dishwashers • Pressed Units • Water Pumps • Compressors • Power-Driven Bench Tools • Stokers • Furnace Blowers • Oil Burners • Refrigerators • Milk Separators • Milking Machines, and many other applications.

Packard
REG. U.S. PAT. OFF. TRADE MARK

GM GENERAL MOTORS

Packard Electric Division, General Motors Corporation
Warren, Ohio

DEPENDABLE APPLIANCE MOTORS FOR THIRTY-FIVE YEARS

If
YOUR INDUSTRY
is on this list—

PAPER
AERONAUTICAL
MACHINE BUILDING
BUSINESS MACHINES
TELEVISION - RADIO
HOUSEHOLD APPLIANCES
SPORTING GOODS
SAFETY FOOTWEAR
AGRICULTURE
AUTOMOTIVE
TEXTILES
MEDICAL
LEATHER

you can benefit from

Tyer

Skill, Imagination & Service

Tyer technical knowledge and original thinking are available to you to make Rubber, our product, more useful to you in your product. The same know-how and resourcefulness that led Tyer to originate White Rubber and Elastic Webbing in the early days of the industry, have enabled Tyer, through war and peace, to supply American manufacturers with

THE UNUSUAL IN RUBBER
SINCE 1856

Tyer
RUBBER COMPANY
ANDOVER, MASSACHUSETTS
159 Duane St., NEW YORK 189 W. Madison St., CHICAGO
6-334 General Motors Bldg., DETROIT

SKINNER STAINLESS STEEL
SOLENOID VALVES

Small size — Rugged — Large capacity

The small size of Skinner Solenoid Valves belies their rugged construction and unusually large capacity. These valves have a standard range from 5 to 250 p.s.i., and a special range from 5 to 850 p.s.i., and can be used for gaseous or liquid media. Their soft insert seat prevents leakage and positive action is assured by spring loading. Skinner Valves may be used in any position, with pipe connections furnished to suit specifications. Power consumption is 10 watts max. Special coils for high humidity or high temperature applications can be supplied. Standard models are approved by Underwriters' Laboratories.

Write for Bulletin No. 501

SKINNER ELECTRIC VALVE DIV.
THE SKINNER CHUCK COMPANY
132 Belden Ave., Norwalk, Conn.

KICK-OFF WITH U.M.H!

Flexibility and Stamina Always Win!

The Universal Metal Hose team makes the goal every time in the conveyance of solids, liquids and gases at high and low temperatures and pressures.

This team, like any winning combination, has been developed to meet all requirements through training and experience.

Every member of the Universal Metal Hose team is designed to do a specific job for you. There's . . .

- Braided Seamless Corrugated
- Interlocked Asbestos Packed High Pressure
- Interlocked Low Pressure — Packed and unpacked
- Square Locked Conduit and special types

in a wide range of metals and sizes.

Universal Catalog U-101 offers you descriptive data on various types and applications of metal hose. Send for your copy today — and send along your specifications for recommendations without obligation.

UNIVERSAL METAL HOSE CO.
2145 S. Kedzie Ave. Chicago 23, Ill.

SAY
AMWELD
WHEN YOU NEED
WELDED...

RINGS
BANDS
COMPONENTS
ASSEMBLIES

Many *"Blue Chip"* companies know that you get quality products, reasonably priced, when made by AMWELD. They're our customers.

Welding is our business — over a third of a century's experience manufacturing circular products that range from fractional horsepower motor shells to jet engine components.

If your products require either fusion or resistance welding of ferrous or non-ferrous metals, send us your prints, specifications and quantities for prompt quotation.

We'll be glad to send our illustrated catalog if you write our Product Development Division.

A Company You'll Like To Deal With

THE AMERICAN WELDING & MANUFACTURING CO. · WARREN, OHIO

140 DIETZ ROAD · WARREN, OHIO

"YOUR PRODUCT WILL ARRIVE IN GOOD CONDITION"—

PACKED IN RUBATEX

Labels warn but do not protect. Pack your product in RUBATEX and you provide essential cushioning which assures "arrival in good condition".

RUBATEX is a closed cellular rubber composed of hundreds of thousands of individually sealed balloon-like chambers in every square inch. Each chamber retains inert nitrogen under pressure and is completely surrounded by a membrane of live rubber. This structure forms a dense resilient cushion which literally smothers impact.

RUBATEX cannot absorb moisture. It has high insulating value—is resistant to oxidation and is rot and vermin proof. It has good compressive strength and is extremely light in weight—only 4½ pounds per cubic foot.

The amazing cushioning and shock-absorbing qualities of RUBATEX closed cellular rubber recommends it as a packing material to better protect your product *all the way*. Most package applications can economically be cut from sheet stock. For further information, write for Catalog RBS-12-49, Great American Industries, Inc., RUBATEX DIVISION, BEDFORD, VIRGINIA.

Dropped from a height of more than one hundred feet, this egg bounced off a three-inch-thick pad of RUBATEX closed cellular rubber without breaking. RUBATEX absorbed and dissipated the impact shock equal to a velocity of more than sixty miles an hour.

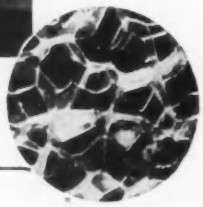


Photo-micrograph of RUBATEX closed cellular rubber shows the tiny individually sealed balloon-like chambers which retain inert nitrogen under pressure.

RUBATEX®

CLOSED CELL RUBBER

FOR GASKETING • CUSHIONING • SHOCK ABSORBING • VIBRATION DAMPING

Superb CASTELL Prints

NO LONGER A LUXURY

Famous CASTELL Drawing Pencil with Imported Lead now available to you at practically no extra cost

CASTELL DRAWING PENCIL 9000

CASTELL LOCKTITE REFILL HOLDER 9400

"Industry demands legible prints—and the making of legible prints begins on the drawing board," states Mr. E. S. Fairley, of the well-known B. K. Elliott Company, Pittsburgh, Cleveland, Detroit.

We agree with him 100%. Imported CASTELL Lead *always* has produced more sharp copies per original drawing than any other pencil on the market. New price ranges now bring CASTELL with imported lead within reach of craftsmen who heretofore used ordinary drawing pencils. You, too, may now enjoy the use of the world's finest drawing pencil at no extra cost. See your Dealer today.

A.W. FABER-CASTELL PENCIL COMPANY INC. NEWARK 4, N.J.

"All motors are NOT alike!"

Check these 15 Reasons Why the RELIANCE Bearing Design is *the BEST one!*

ONLY ONE MOTOR HAS ALL THESE DESIGN FEATURES:	DESIGN A Prelubricated cartridge—bearing mounted in bracket	DESIGN B Open bearing mounted in bracket	RELIANCE Double-shielded, prelubricated bearing mounted in bearing cap
Bearing sealed from dirt and other foreign material	YES	NO	YES
Enclosed bearing housing	NO	YES	YES
Bearing can be relubricated without being disassembled	NO	YES	YES
Motor can be regreased without removing drain plug	**	NO	YES
Automatic grease relief to suit any lubrication system	NO	NO	YES
Protection against grease entering windings	YES	*YES	YES
Balls free of direct pressure during lubrication	YES	NO	YES
Bearing can be removed without danger of distortion	NO	NO	YES
Reservoir to protect against overgreasing	NO	YES	YES
Standard commercial ball bearings	YES	YES	YES
Larger grease reserve than provided with any standard bearing	NO	YES	YES
Grease supply free of churning action	NO	NO	YES
Measuring unnecessary to prevent overgreasing	NO	*YES	YES
Unnecessary to grease equally at each side of ball race	NO	YES	YES
Lubricant is retained in ball race	YES	NO	YES

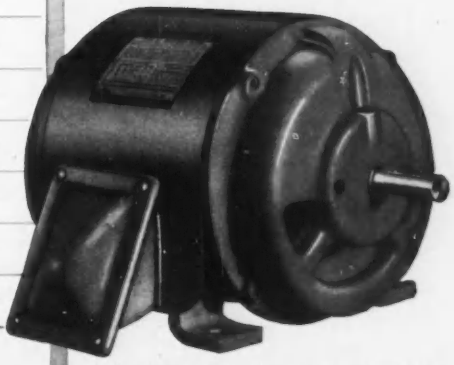
** Means is not provided for relubrication of assembled motor.
*YES, if drain plug is removed.

The Reliance Pre-lubricated Bearing Design has all of the features vital to maximum motor life. Check these points in the chart at left. The performance of Reliance PRECISION-BUILT Motors in all industries and under all operating conditions has proved their value in long-wearing, trouble-free bearing design.

In most applications, Reliance PRECISION-BUILT Motors operate satisfactorily for years without relubrication. Where it is a practice to grease regularly or where operating conditions make it desirable . . . it is impossible to overgrease a Reliance Motor. Write for *new* Bulletin B-2201 for the "inside story" of the Reliance Pre-lubricated Bearing Design.

RELIANCE Precision-Built MOTORS

Reliance PRECISION-BUILT A-c. Motors from ¾ to 300 Hp.



Sales Representatives in Principal Cities

RELIANCE ELECTRIC AND ENGINEERING CO.

"All Motors are NOT Alike" • 1080 Ivanhoe Road, Cleveland 10, Ohio

If your problem is finding the right finish to replace conventional chrome plating, follow the lead of prominent manufacturers of all types of products . . . switch to zinc plate and Iridite Bright.

Here's what you get when you use this chromate finishing system: to replace conventional chrome plating.

SPARKLING BRIGHT APPEARANCE

The zinc plate and Iridite Bright system resembles chrome so closely that visual inspection can scarcely tell the difference! And, the brilliance *lasts*.

BETTER CORROSION PROTECTION

Yes, you actually get better protection with zinc plate and Iridite Bright than with chrome plating . . . up to twice the life under accelerated salt spray conditions! And, by applying a clear baking lacquer over the Iridite coating you can increase the abrasion resistance and lasting qualities of this bright finishing system, at the same time making possible a greater salt spray protection.

LOWER FINISHING COSTS

One metal, zinc, replaces three so you save material costs and plating time. Iridite Bright goes on in a non-electrolytic chemical dip.

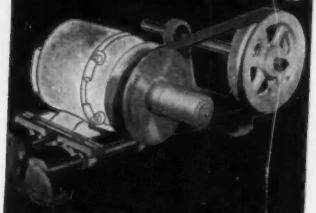
Write or call today for your copy of our new Technical Bulletin describing all phases of this bright finishing system in detail. Tell us your bright finishing requirements. If possible send sample parts for test processing.

Iridite is approved under government specifications

ALLIED RESEARCH PRODUCTS
INCORPORATED
4004-06 E. MONUMENT STREET • BALTIMORE 5, MD

WANTED! Speed-Change PROBLEMS

GERBING
ROTO-CONE
Complete *VARIABLE SPEED DRIVES*



- Variable Speed Pulleys
- Adjustable Motor Bases
- Countershaft Bases
- V-Belts
- V-Driven Sheaves

Here's the "Why" of Roto-Cone's Superiority...

V to V DRIVE
sizes ⅛ to 15 h.p.

UP TO 4 to 1
Speed-Change Ratio

Straight Line
Base Adjustment

Here is Industry's most versatile speed control drive. Rack and pinion arrangement, *exclusive* in Roto-Cone, provides equal and opposite lateral movement of both discs, therefore V-belt *always* travels on a fixed center line. Result is maximum, vibrationless transmission of power and full belt life. No expensive angular base mounting required.

Write for details and the assistance of our speed control engineers.

GERBING MFG. CORP.
Dept. G, NORTHBROOK, ILL.
(Suburb of Chicago)

Van Huffel
cold-formed metal tubing
and shapes solve problems
for the makers
of

farm equipment

It may be a far cry from vegetables to Van Huffel, but farm equipment manufacturers will tell you they are both basic in the scheme of things.

For instance, where deadweight must be cut from a tractor without sacrificing strength . . . where a farm implement must be easier to carry, move or lift without complicated fabrication . . . a lot of production problems are being solved by the versatility of Van Huffel metal shapes and tubing.

VAN HUFFEL

TUBE CORPORATION • WARREN, OHIO

WELDED, LOCK SEAM, OPEN SEAM, BUTTED TUBING, SHAPES AND MOULDINGS

Garlock
"Chevron" Seal

Wherever leakless operation is required—specify GARLOCK Mechanical Seals

When leakless operation of centrifugal or rotary pumps is required—particularly, if corrosive or inflammable liquids are being handled—GARLOCK Mechanical Seals will do the job.

These seals are composed of two main elements; one rotates with the shaft and the other is stationary. Since the stationary element does not contact the shaft, there is *no* wear on the shaft. A positive contact between carefully lapped metal-to-carbon or, metal-to-metal mating surfaces provides the leakless seal.

Users of GARLOCK Mechanical Seals have reported outstanding service records on a wide variety of applications. Here are just two taken from the many in our files:

- Over 3 years' service and still in operation, on a 1¾" shaft of a boiler feed pump handling water at 220°F. and 200 p.s.i., and operating at 3600 r.p.m.
- Two years' service, and still in operation, on a 1" shaft of a pump handling paint at 130°F., 10' Hd., operating at 1750 r.p.m.

GARLOCK manufactures mechanical seals in many standard and special designs from a wide range of high quality materials. For more information, write for our Mechanical Seal booklet or call your GARLOCK representative.

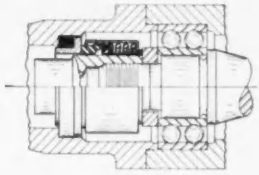
THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK

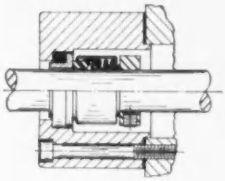
In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.

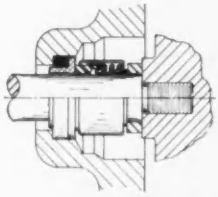
GARLOCK

TYPICAL APPLICATIONS of GARLOCK Mechanical Seals for Rotary Shafts

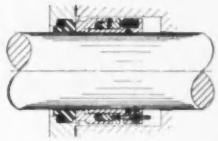
PACKAGE SEALS





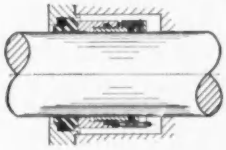


CHEVRON-TYPE SEALS



Type CB—Balanced "Chevron" Seal

"O" RING SEALS



Type OB—Balanced "O" Ring Seal

Springboard

for new ideas in metal products design and fabrication

SuVeneer®
CLAD METAL

Take-off from the performance facts of SuVeneer Clad Metal . . . into a new realm of design opportunities for superior product economy and service! SuVeneer Clad offers the surface advantages of solid copper (or copper alloy,) plus the inherent physical properties of low carbon steel to which it is inseparably bonded—giving a free hand to fabrication by any usual method. We have a useful bulletin on the physical properties of *SuVeneer Clad Metals*—write for it. And we'll gladly consult with you on your future planning.

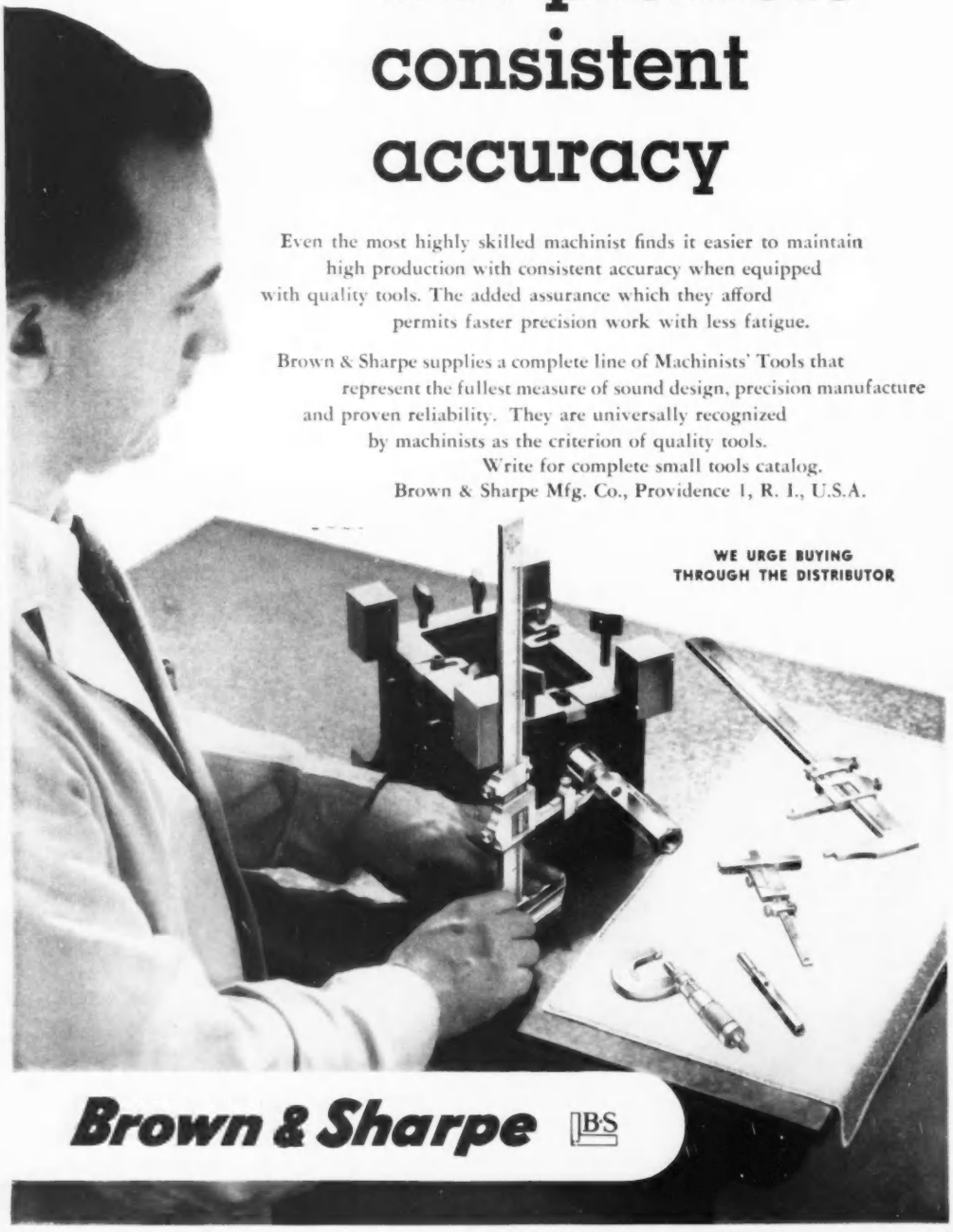
Superior Steel
CORPORATION
CARNEGIE, PENNSYLVANIA

fine tools that promote consistent accuracy

Even the most highly skilled machinist finds it easier to maintain high production with consistent accuracy when equipped with quality tools. The added assurance which they afford permits faster precision work with less fatigue.

Brown & Sharpe supplies a complete line of Machinists' Tools that represent the fullest measure of sound design, precision manufacture and proven reliability. They are universally recognized by machinists as the criterion of quality tools.

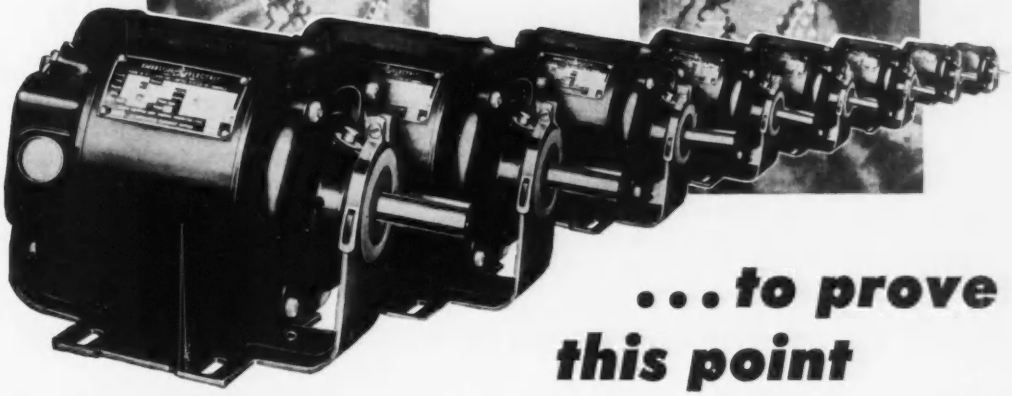
Write for complete small tools catalog.
Brown & Sharpe Mfg. Co., Providence 1, R. I., U.S.A.



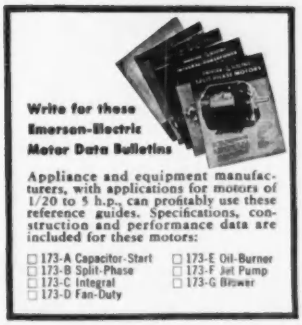
WE URGE BUYING
THROUGH THE DISTRIBUTOR

Brown & Sharpe B·S

Two are Better Than One



. . . to prove this point



Write for these Emerson-Electric Motor Data Bulletins

Appliance and equipment manufacturers, with applications for motors of 1/20 to 5 h.p., can profitably use these reference guides. Specifications, construction and performance data are included for these motors:

- ☐ 173-A Capacitor-Start
- ☐ 173-B Split-Phase
- ☐ 173-C Integral
- ☐ 173-D Fan-Duty
- ☐ 173-E Oil-Burner
- ☐ 173-F Jet Pump
- ☐ 173-G Blower

There's nothing unusual in being able to produce *one good motor.* But when that single unit must be multiplied by thousands, and all must match the original, it is a factor you should consider in selecting the motor for your products.

In Emerson-Electric motors, uniformity in appearance is unquestioned. *Uniformity of performance,* the important factor, has earned for them wide acceptance among America's leading appliance and equipment manufacturers. Knowing the reputation of their products is determined by uniformly dependable performance, these manufacturers turned to Emerson-Electric motors.

More than 61 years of precision motor production has made uniformity one of the many advantages inherent in Emerson-Electric motors. For full information on this complete line of motors in the 1/20 to 5 h.p. range, write today to:

THE EMERSON ELECTRIC MFG. CO.
St. Louis 21, Mo.

EMERSON ELECTRIC
MOTORS • FANS — APPLIANCES

In hydraulic pumps

GEROTOR

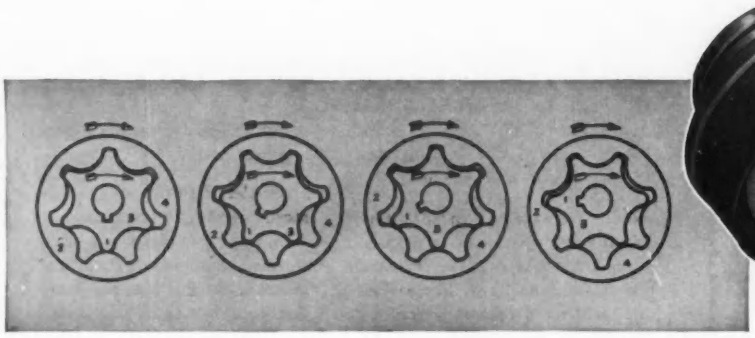
is more than a name—

it's the principle of the thing!

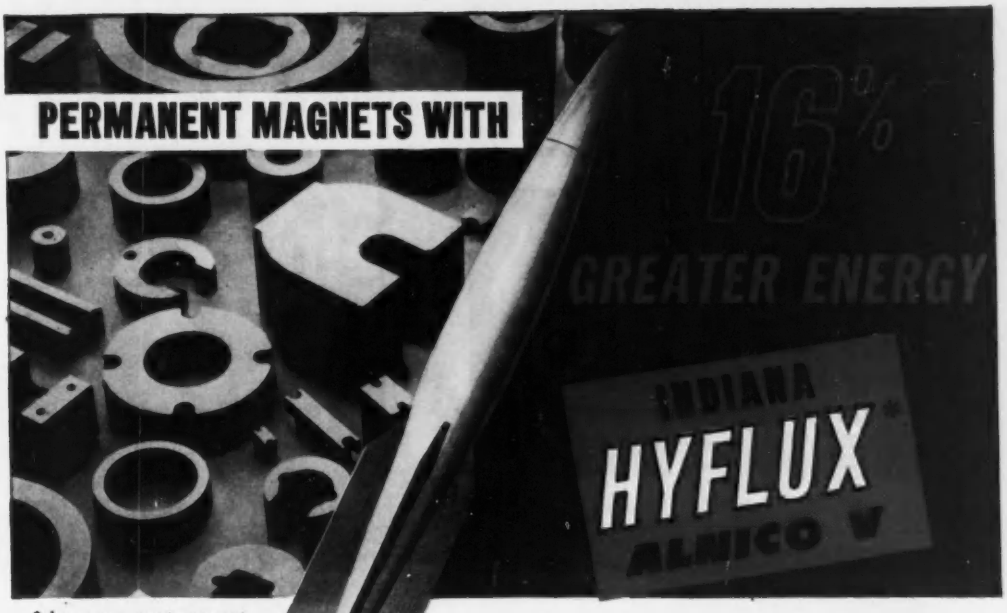
The unique Gerotor principle, found in no other hydraulic pumps, operates with high volumetric and mechanical efficiency. Both Gerotor elements revolve in the same direction at low relative speed, resulting in less wear, longer life. Continuous fluid-tight tooth engagement means less slippage, more uniform flow. Note the relative advance of teeth and spaces in the diagrams below.

Gerotor hydraulic pumps are engineered for pressures up to 1000 p.s.i., continuous duty; in some sizes, up to 1200 p.s.i., continuous, and 1500 p.s.i., intermittent. Deliveries range from .4 g.p.m. at 1800 r.p.m. to 40 g.p.m. at 1200 r.p.m. Plain, base or flange mounting. Models available for two separate circuits. Write for Catalog Sections G-101, G-103, G-104, G-106.

GEROTOR MAY CORPORATION—P. O. Box 86, Baltimore 3, Maryland



GEROTOR hydraulic pumps & motors

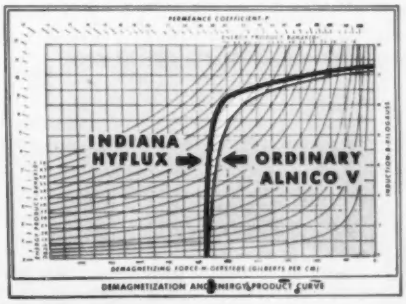


*the permanent magnet material that offers an average energy product of 5½ million BH max or more, with 5¼ million *guaranteed!*

INDIANA HYFLUX Permanent Magnets are vital components of guided missiles, proximity fuses, radar and thousands of other military and industrial applications.

There is logic in selecting INDIANA HYFLUX Alnico V for every application calling for permanent magnets.

With its 16% greater energy product, it performs old applications better and at the same time permits more compact design in new products. Yet premium quality INDIANA HYFLUX Alnico V costs no more than regular Alnico V.


INDIANA HYFLUX
ORDINARY ALNICO V
DEMAGNETIZING FORCE IN OERSTEDS (GILBERTS PER CM.)
DEMAGNETIZATION AND ENERGY PRODUCT CURVE

WHAT IS INDIANA HYFLUX ALNICO V?

INDIANA HYFLUX Alnico V is not a new alloy. It is the result of new precision techniques applied to dependable Alnico V, including new procedures, controls, instrumentation, equipment — and PRECISE supervision over every step of production.

It's the most important development in permanent magnets since the introduction of Alnico V itself!

ALL SIZES, SHAPES AND MATERIALS!

INDIANA is the only manufacturer furnishing all commercial grades of permanent magnet alloys. You have a choice of cast, sintered, formed or ductile materials.

Many types and sizes of INDIANA HYFLUX Alnico V permanent magnets are available from stock for your experiments.

LET OUR ENGINEERS HELP YOU!

THE INDIANA STEEL PRODUCTS COMPANY, world's largest producer of permanent magnets, offers free of charge every engineering assistance in the design and application of permanent magnets best suited to your products.

Take advantage of this wealth of experience and "know how" that has developed more than 30,000 successful applications.

Write, wire, or phone INDIANA today! Ask for Catalog No. 11C-1, that describes stock experimental magnets.

INDIANA PERMANENT MAGNETS

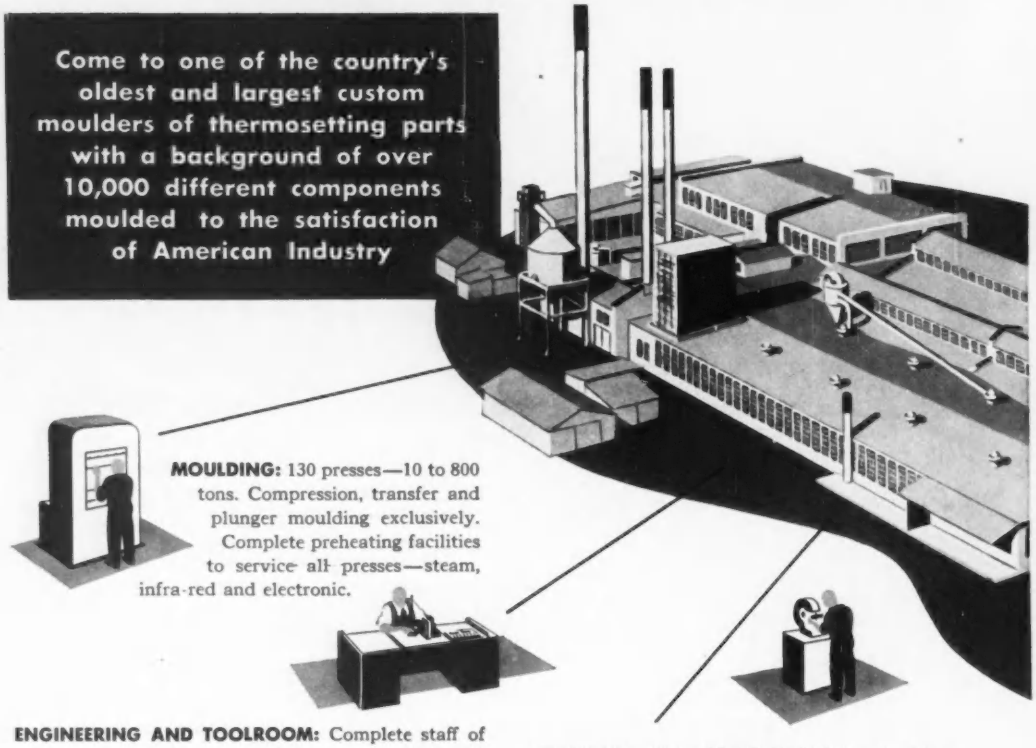
THE INDIANA STEEL PRODUCTS COMPANY

VALPARAISO, INDIANA • • • Sales Offices Coast to Coast

SPECIALISTS IN "PACKAGED ENERGY" SINCE 1908

Come to Kurz-Kasch

Come to one of the country's oldest and largest custom moulders of thermosetting parts with a background of over 10,000 different components moulded to the satisfaction of American Industry



MOULDING: 130 presses—10 to 800 tons. Compression, transfer and plunger moulding exclusively. Complete preheating facilities to service all presses—steam, infra-red and electronic.

ENGINEERING AND TOOLROOM: Complete staff of engineers and designers. Toolroom equipped for all mould making as well as special jigs and fixtures. Keller duplicating machine, 2,000-ton hobbing press, heat-treat equipment in addition to standard line of mills, lathes, etc.

FINISHING AND ASSEMBLY: Drilling, tapping, sanding, polishing, buffing, filing, profiling, tumbling, painting. Plenty of equipment for economically finishing any type of plastic part. Conveyor lines for speedy, efficient assembly work.

Kurz-Kasch

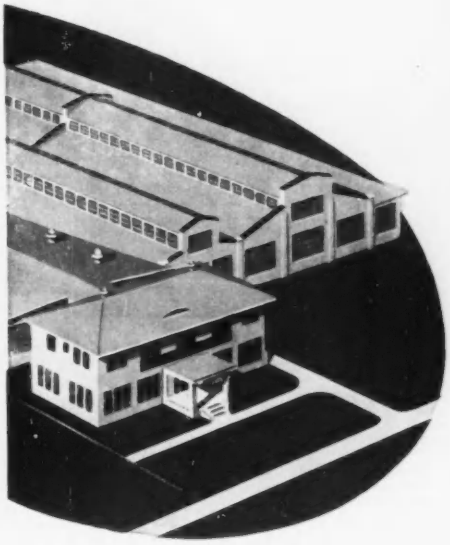
For over 35 years Planners and Moulders in Plastics

Kurz-Kasch, Inc. • 1415 South Broadway • Dayton 1, Ohio

Branch Sales Offices: New York, *Lexington 2-6677* • Rochester, *Hillside 2415-M* • Chicago, *Harrison 7-5473* Detroit, *Trinity 3-7050* • Philadelphia, *Granite 2-7484* • Dallas, *Lakeside 1022* • Los Angeles, *Richmond 7-5384* St. Louis, *Delmar 9577* • Toronto, *Riverdale 3511* • Export Office: 89 Broad St., New York City, *Bowling Green 9-7751*

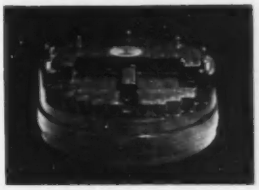
for Plastics Plus

All Thermosetting Materials—Teflon—Glass-Filled Polyester



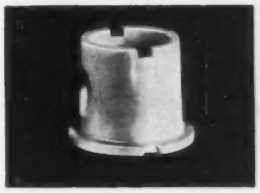
COMPANY POLICY: We have specialized in the moulding of thermosetting materials for the last 35 years, and we are today one of the foremost producers in the field. We pride ourselves on the truthful application of plastics—and this policy has netted us scores of customers who, as old friends, we still serve in the second generation. We are equipped to handle the entire job from design to finishing—to accept full moulding responsibility—to produce in large volume and ship on schedule. The K-K trademark on a plastic part stands for dependability—a promise made and met. Our consulting engineers are as close to you as your phone.

What K-K Research and Development Technique Have Meant



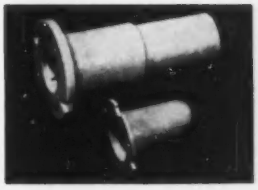
STANDARD THERMOSETTING MATERIALS

Eight years ago a new material—an asbestos rag-filled Melmac—was developed into this "heretofore impossible" application. We've been meeting production schedules with the original moulds—on time—at a fair price—ever since.



TEFLON VALVE LINER

Teflon is the most chemically inert material known—resists all acids, alkalies, etc.—is non-toxic—has zero water absorption—resists temperatures of 500° F. continuously—has excellent electrical qualities. Nothing known adheres to it—and moulded-in wax-like surface permits free turning without lubricants. We specialize in moulding complex shapes only—where machining of tube, rod or bar stock is undesirable. One of the first in the country to mould such shapes, we developed our own technique of pressing preforms, sintering and coining.



GLASS-FILLED POLYESTER ELECTRICAL PART

Now Kurz-Kasch engineers have solved the problem of moulding this material in complex forms and shapes—with holes and variable wall sections. CHARACTERISTICS: As a thermosetting resin, polyester offers excellent dimensional stability—good electrical characteristics—good resistance to chemicals and medium high temperatures. The glass fibres, with high tensile strength, are a good electrical insulator, are chemically inert and heat resistant. We will gladly discuss applications with you.

Immediate Delivery

on these AIR VALVES

...because we planned our 1950 production facilities with 1951 in mind!

Write, Wire or Call Today!

TESTED – PROVEN – ACCEPTED!

CHOOSE THE

AIR VALVE

YOU HELPED DESIGN

Best for Trigger-Quick Control of All Air Operated Equipment

• FULL FLOW • COMPACT • ONE MOVING PART

Send for FREE Catalog

MAC

MECHANICAL AIR CONTROLS, INC.

15315 W. 11 MILE RD. • ROYAL OAK, MICHIGAN

HARPER *can tell you...*

because Harper deals in them *all!* Long experience and specialized production in all types and sizes of fastenings in *all* alloys mean just the right kinds for your needs—whether your problem is corrosion, abrasion, heat, stress, or appearance. Over 7000 items—bolts, screws, nuts, rivets and accessories—in stock ready for delivery from warehouses and distributors, nationwide. Send coupon for information and new Harper Catalog.

HARPER

EVERLASTING FASTENINGS

The H. M. Harper Co.,
8203 Lehigh Ave., Morton Grove, Ill.

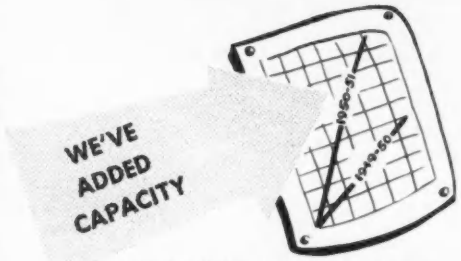
Send my free copy of the new Harper Catalog. (Please Print)

Name .....

Address .....

City .....State.....

SPECIALISTS IN ALL NON-CORROSIVE METALS



WE'VE ADDED CAPACITY

TO HANDLE YOUR EXPANDED CIVILIAN AND WAR NEEDS

FOR SCREENS, STRAINERS, FILTERS

Production space has been increased by 100% and new modern equipment added giving new high standards in performance. Included in new equipment are special production machines that are particularly suited to do crimping and brazing required in strainers used in defense work. Storage space has been enlarged permitting handling of WIDER RANGES of monel and brass wire cloth and perforated metal. Send us your specifications for a speedy quote. Write for FREE Literature.

PITTSFIELD PRODUCTS, Inc.

ANN ARBOR, MICHIGAN

Take a "BIG BITE" out of Product Costs

Put teeth in your power drives with DAYTON COG-BELTS *T. M.

★ DELIVER 40% MORE H.P. ★ SAVE UP TO 28% DRIVE WEIGHT ★ SAVE UP TO 47% DRIVE SPACE

Patented premium Dayton Cog-Belts with rayon cords, actually improve performance of your product, while *lowering* its cost!

They deliver 40% more horsepower than ordinary V-Belts of the same cross-section size. On a 40 H.P. C-section drive you save the cost of two belts, four pulley grooves, as 5 Cog-Belts do the job of 7 ordinary belts. This drive weighs 28% less, takes up 47.2% less space than an ordinary V-drive. You save on shipping, handling, warehousing your product.

You save, too, because your product *keeps* sold and trouble-free. Cog-Belts are built to bend (like the joints of your finger). They stand flexing strains, starting and shock loads better, last years longer. To add these premium features to your product, write for latest engineering data on the Cog-Belt.

DAYTON RUBBER COMPANY, DAYTON 1, OHIO

V-Belts by **Dayton Rubber**

WORLD'S LARGEST MANUFACTURER OF V-BELTS

new Synchronizing Contactor
for the **STROBOTAC**® and the **STROBOLUME**

To meet an insistent demand from users of the General Radio stroboscopes for a versatile contactor, by means of which the STROBOTAC or STROBOLUME can be 'fired' from a mechanical contact with any rotating shaft, we announce the new Type 1535-A CONTACTOR.

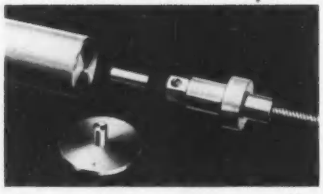
This unit has a powerful magnetic clutch, on the end of an 18-inch flexible shaft, which can be attached to any shaft of magnetic-sensitive material, even while the shaft is rotating.

The rotating clutch in turn drives an electrical contactor in the housing of the assembly. The contactor automatically synchronizes with the rotating shaft. Irrespective of changes in speed, the stroboscope is always in synchronization with the rotating shaft.

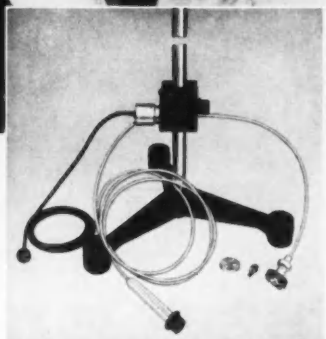
Flashes can be timed to occur at any position of the shaft, by either rotating a hand-held knob on the end of an 8-foot flexible cable, or by turning the knob mounted on the body of the contactor. The angular position of the contacts can be set anywhere within 360 degrees, the positioning scale being calibrated every 5 degrees to facilitate resetting.

There are six equally spaced contacts in the assembly. They can be connected to give combinations of 1, 2, 3 or 6 equally spaced flashes per shaft revolution.

This magnetic contactor greatly increases the utility of General Radio stroboscopes in industry, providing a simple, reliable and accurate means for timing the stroboscopic flashes to synchronize automatically with any rotating shaft.

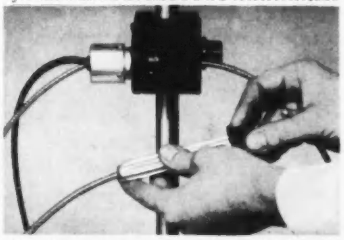


The accessories shown above are supplied with the Contactor. The steel disc in the foreground is used when the magnetic clutch is to be attached to non-magnetic or small shafts. The short rod can be fitted into a hole drilled in the shaft so that the screw-set coupling can be attached to the shaft for permanent or semi-permanent set-ups.



The contactor assembly can be locked in position at any point on a 4-foot upright mounted on a heavy cast-iron base. The range of height adjustment is 6 inches to 4 feet; or the assembly can be removed from the stand and mounted permanently on a machine.

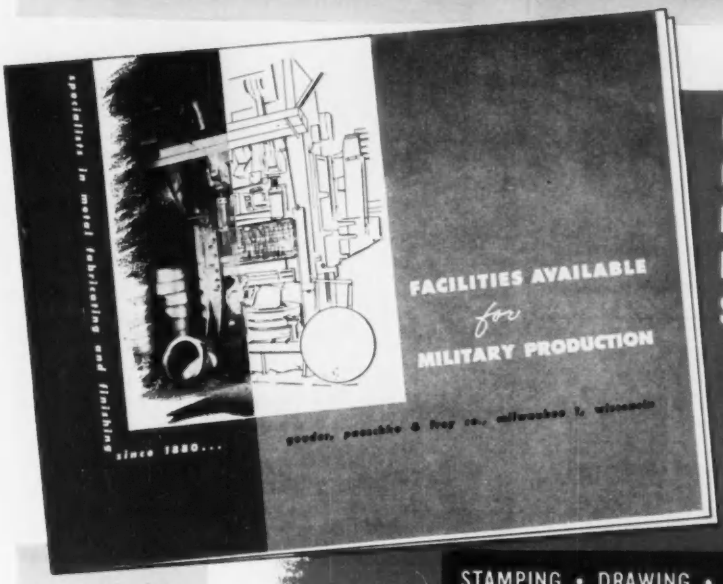
Type 1535-A Contactor **$140.00**
Type 1535-P1 Adaptor Cable
for use with the STROBOTAC **$5.50**



By rotating the knob held in the hand (above) or the knob on the contactor housing, flashes from the stroboscope can be made to occur at any position of the rotating shaft. For resetting purposes the position of the contacts is indicated every 5 degrees on a 360-degree scale.

GENERAL RADIO Company
275 Massachusetts Avenue, Cambridge 39, Mass.
90 West Street NEW YORK 6 — 920 S. Michigan Ave. CHICAGO 5 — 1000 N. Seward St. LOS ANGELES 38

NEED HELP ON YOUR MILITARY ORDERS?



GET THIS BOOK OF FACTS ON OUR COMPLETE METAL FABRICATING FACILITIES FOR SUB-CONTRACT WORK

G.P.&F.
DEFENSE DIVISION
MILWAUKEE

STAMPING • DRAWING • FORMING • TINNING
GALVANIZING • SPRAY FINISHING • WELDING
VITREOUS ENAMELING • LEAD COATING

Typical Examples of Military Sub-contract Work

Electric Light Hood

Motor Housing

Frame for Diving Helmet

Transmitter Case

Transmitter Case and Cover

Radio Receiver Case

Oil Pan

Fuel Tank

Industrial Vacuum Cleaner Housing

Time Control Box

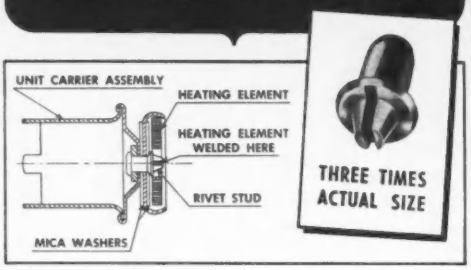
Aerial Delivery Container

• It's right off the press! Send for your FREE copy today! Gives details of this nationally-famous, 70-year-old company's technical efficiency, wide experience, modern facilities and ample capacity . . . to produce stampings of every description—whether simple or intricate in design. Whatever your metal fabricating problem may be . . . for military or civilian use . . . consult G. P. & F.

15 Acres of Production Facilities
Complete Machine Shop and Tool and Die Department

DEFENSE DIVISION
GEUDER, PAESCHKE & FREY CO.
1505 W. ST. PAUL AVE. • MILWAUKEE 1, WISCONSIN

RUGGED LITTLE RIVET HAS TWO BIG JOBS



Small enough to put under your fingernail, this rivet is made by Progressive for The Cuno Engineering Corporation. Used in an automotive cigarette lighter, it serves as a post to which the center of the heating coil is spot welded and as a rivet for fastening the burner cup to the lighter shell.

This double function required precise upsetting of a metal sufficiently soft to be used as a rivet, yet rugged enough to withstand the welding operation.

At Progressive, we welcome special jobs like these. It's our business and we're good at it. See Progressive—if it's a SPECIAL.

WRITE FOR OUR CATALOG
IT MAY SAVE YOU MONEY

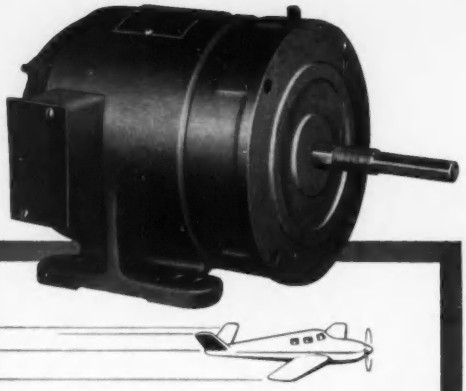
Other typical **PROGRESSIVE** *"Specials"*

QUALITY PROMCO BRAND

THE PROGRESSIVE MANUFACTURING COMPANY

48 NORWOOD ST., TORRINGTON, CONN.

SALES OFFICES: SAN FRANCISCO, LOS ANGELES, PORTLAND, DETROIT, PHILADELPHIA, CLEVELAND, SEATTLE, BOSTON, SYRACUSE, ST. LOUIS, CHICAGO.



Your Peerless Electric Motor Department can serve you promptly

ONE of the finest motor engineering staffs can be your motor department when you call on Peerless Electric.

Peerless private air service—a Beechcraft Bonanza—can carry one of our sales engineers to see you on reasonably short notice, if necessary. He'll get to your problem quickly—right at your desk with your own designers—ready to work out the toughest motor problem.

Peerless Electric motor engineering, noted for dependability and versatility since 1893, is as progressive as the modern age, and now, more than ever, available as the motor department of your business.

THE PEERLESS ELECTRIC CO., WARREN, OHIO

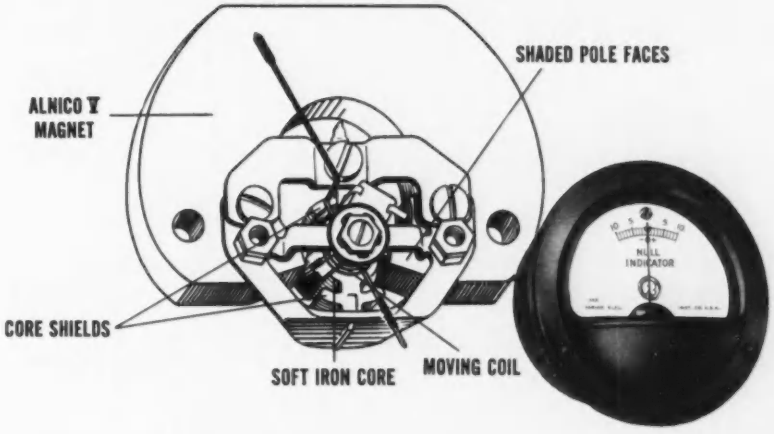
Manufacturers of Quality Motors Since 1893

Single Phase • Polyphase • Direct Current • ¼ to 15 H.P.

ALL *Peerless Motors* ARE "PEERLESS REGISTERED"

NEW

the marion Sensitive, Ruggedized Null Indicator



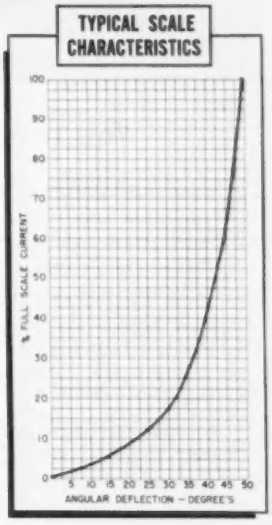
The Marion RUGGEDIZED Null Indicator offers advantages never before found in meters of this kind.

Its special construction permits the use of the null system for precise measurements under very severe field conditions, allows design engineers to use a Null Indicator in new applications.

This meter is hermetically-sealed and its mounting requirements and physical dimensions are in conformance with JAN-I-6. It has very high center-point sensitivity (1 microampere per mm. or higher), yet due to its shaded pole face and shielded core construction it gives sharply logarithmic attenuation as it departs from the null point, thus providing ample overload protection for the indicator. Maximum safe current is ten times actual rated full scale value.

The Marion Null Indicator is made in two models, the HS2 (2½" size) and the HS3 (3½" size). Each of the two models is available with numerous current sensitivity and internal resistance characteristics.

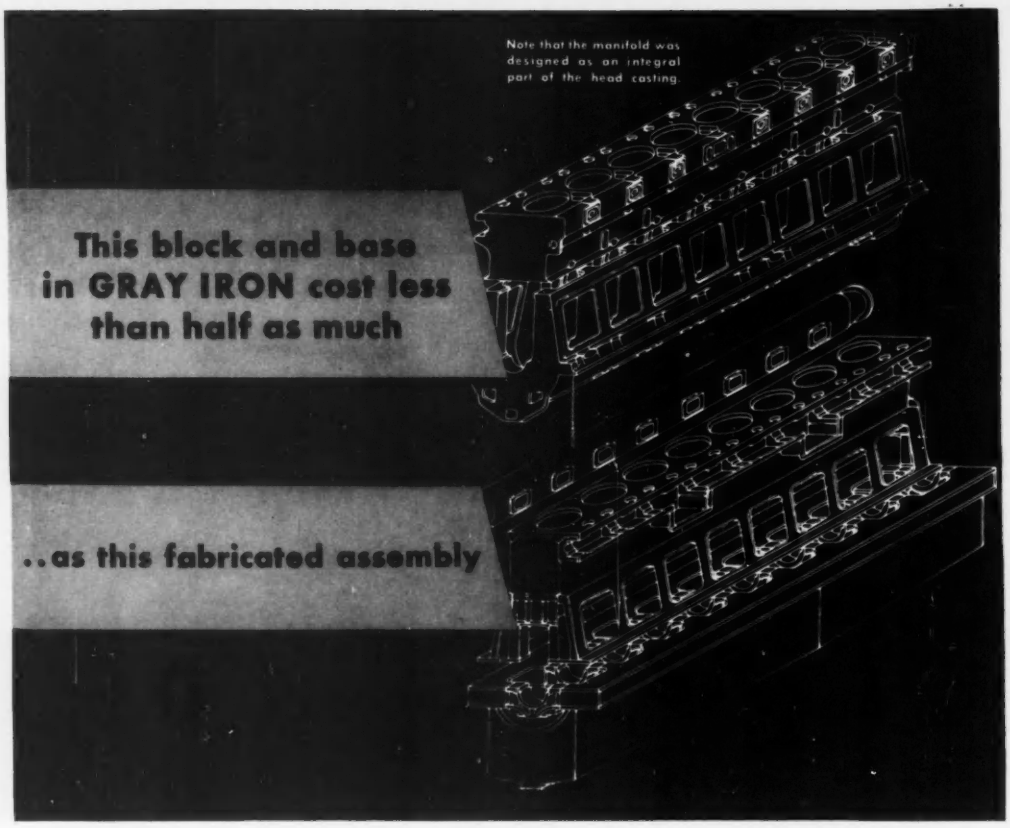
Demands of our national mobilization program come first, of course, but we will gladly supply further information and serve you to the best of our ability.



MARION ELECTRICAL INSTRUMENT CO., 401 CANAL ST., MANCHESTER, N. H.

marion meters

MANUFACTURERS OF MARION Ruggedized PANEL METERS


Note that the manifold was designed as an integral part of the head casting.
This block and base in GRAY IRON cost less than half as much
..as this fabricated assembly

You can't afford to pass up savings like this!

GRAY IRON CASTINGS COST LESS than fabricated assemblies in over 90 per cent of the cases studied by the manufacturer of this well-known diesel engine (name on request). Shop records of this manufacturer indicate that average savings of 50% can be obtained by using castings.

BETTER STILL—GRAY IRON GIVES YOU MORE ADVANTAGES than any other single production material or method of production: Castability, Rigidity, Low Notch Sensitivity, Wear, Heat and Corrosion Resistance . . . Durability . . . Vibration Damping . . . Machinability, Wide Strength Range.

CONSIDER GRAY IRON FIRST for maximum flexibility of design at minimum cost. Progressive design engineers do—that's why the gray iron foundry industry is the second largest in the metal-working field.

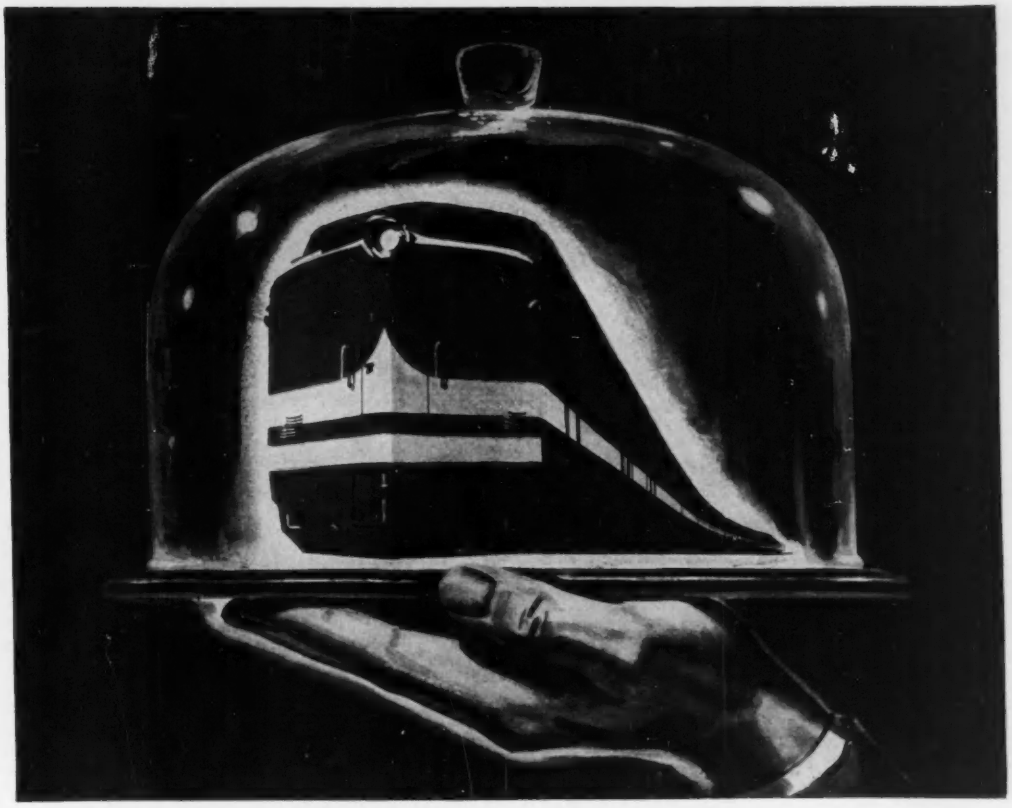
Make it Better with Gray Iron

Second largest industry in the metal-working field

SCRAP IS NEEDED FOR DEFENSE—KEEP IT MOVING!

GRAY IRON FOUNDERS' SOCIETY, INC.

NATIONAL CITY-E. 6th BLDG., CLEVELAND 14, OHIO



Under Glass... THEY'D LAST FOREVER!

If you could pack your electrical apparatus in glass, there's no telling how long it would last!

But it's service use that pays off in profits, so a prominent locomotive maker chose the next best use for the protective qualities of glass—or, more specifically, insulating materials made with Fiberglas* yarns.

Here's how he does it:

Electric traction motors that directly drive the wheels on diesel-electric engines, normally have a usable life of only 600,000 road miles. Armatures and coils insulated with organic materials break down under service use, causing costly down-time.

The solution: Coil and armature insulation made with Fiberglas glass-base materials and silicones which permit higher currents, resist heat far longer. The result: traction motor ratings increased from 700 to 835 amperes . . . braking effort upped 23% . . . locomotive rating upped 25% . . . and, most important of all, *road-mile life increased 8 times!*

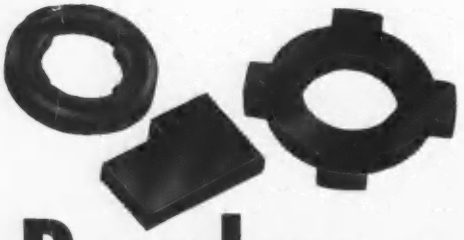
This is just one example of product improvement made with Fiberglas glass-base insulations. If you make or use electrical apparatus, it will pay you to investigate Fiberglas insulating materials.

OWENS-CORNING FIBERGLAS CORPORATION, ELECTRICAL SALES DIVISION, 16 East 56th Street, New York 22, N. Y.

OWENS-CORNING FIBERGLAS

FIBERGLAS IS IN YOUR LIFE . . . FOR GOOD!

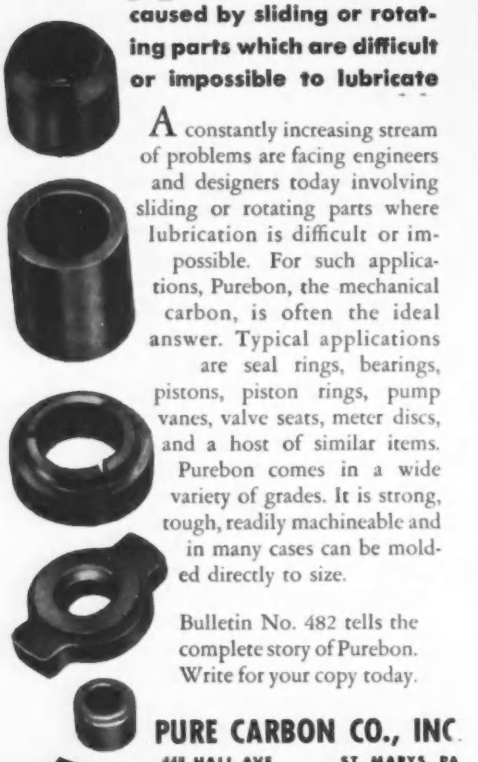
*Fiberglas is the trade-mark (Reg. U. S. Pat. Off.) of Owens-Corning Fiberglas Corporation for a variety of products made of or with glass fibers.



Purebon

solves many problems

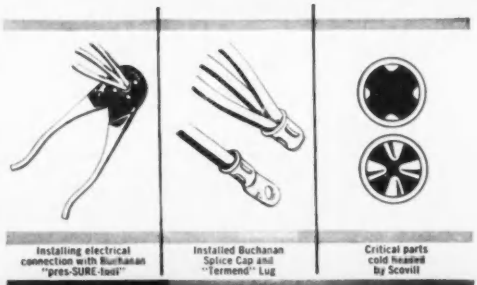
caused by sliding or rotating parts which are difficult or impossible to lubricate

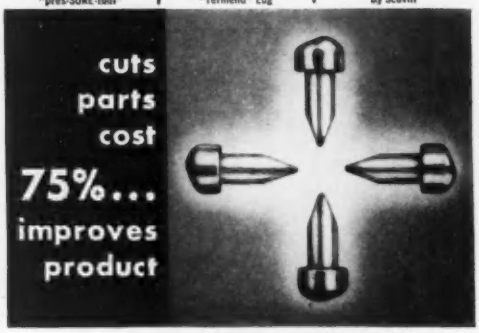


A constantly increasing stream of problems are facing engineers and designers today involving sliding or rotating parts where lubrication is difficult or impossible. For such applications, Purebon, the mechanical carbon, is often the ideal answer. Typical applications are seal rings, bearings, pistons, piston rings, pump vanes, valve seats, meter discs, and a host of similar items. Purebon comes in a wide variety of grades. It is strong, tough, readily machineable and in many cases can be molded directly to size.

Bulletin No. 482 tells the complete story of Purebon. Write for your copy today.

PURE CARBON CO., INC.
448 HALL AVE. ST. MARYS, PA


Installing electrical connection with Buchanan "pres-SURE-lock"
Installed Buchanan Splice Cap and "Termend" Lug
Critical parts cold headed by Scovill



with SCOVILL cold heading

This special crimping tool, manufactured by Buchanan Electrical Products Corp., makes electrical splices and terminations, quickly and easily. The wedge-shaped parts which do the actual crimping formerly required four different manufacturing operations. Now they are cold headed by Scovill at about one-fourth their previous cost.

Perhaps Scovill cold heading can help shortcut your way to lower production costs, in a new product you now have on the board, or one up for re-design. Your sample, blueprint or outline of your problem will get prompt attention from Scovill's cold heading design experts.

"Guide to the Profitable Use of Cold Heading"—Bulletin No. 2 describes the advantages and limitations of this process for the designer. It's free for the asking.

A PRODUCT OF SCOVILL

RECESSED HEAD SCREWS • SEMS • TAPPING SCREWS
STANDARD MACHINE SCREWS • SPECIAL COLD HEADED PARTS

SCOVILL FASTENERS AND SPECIAL PARTS

INDUSTRIAL FASTENER SALES, WATERVILLE DIVISION
SCOVILL MANUFACTURING CO., WATERVILLE 14, CONN.
Montclair, N. J. • Detroit • Wheaton, Ill. • Cleveland • San Francisco • Rochester, N.Y.

GEARS... that live up to a Reputation

Cutting a Philadelphia Helical Gear. These can be furnished up to 150" diameter.

If you do not have a copy of the Gear Catalog 48, you should send for it today. This 68 page book will help you understand, design and order gears. Just send your request on your business letterhead and a copy will soon be in your hands.

For nearly 60 years Philadelphia Gears have been known throughout industry for high quality and precision manufacture. Our modern plant contains the latest equipment for cutting, machining, hardening and testing every type of gear—large or small—and in any quantity. That's why we have been called "Gear Headquarters" . . . and why so many firms always rely on Phillie Gear for every gear need.

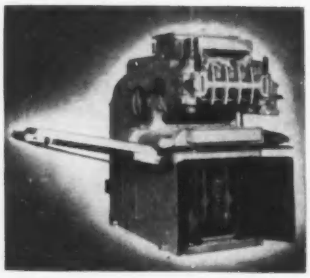
Philadelphia Gear Works, INC.

ERIE AVE. AND G ST., PHILADELPHIA 34, PA.

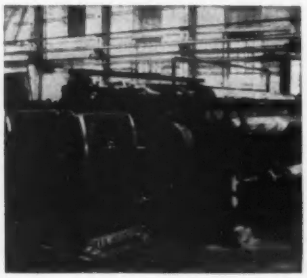
NEW YORK • PITTSBURGH • CHICAGO • HOUSTON • LYNCHBURG, VA.
IN CANADA: WILLIAM AND J. G. GREEY LIMITED, TORONTO

Industrial Gears and Speed Reducers
LimiTorque Valve Controls

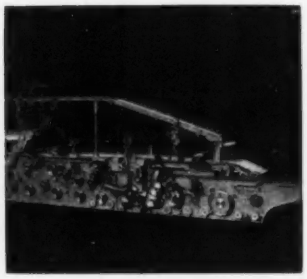
Baker-Perkins Dough Divider



Black-Clawson Paper Cutter

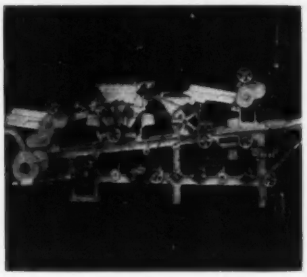


Thos. L. Green Cracker Embossing Machine



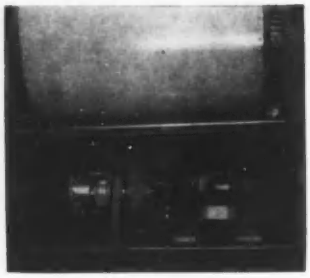
Blakeslee Vertical Mixer

Thos. L. Green Cutting Machine



LEWELLEN *Controls...*

Thos. L. Green Dough Mixer



GIVE YOU THE SPEED YOU WANT . . . WHEN YOU WANT IT!

"At what speed should my machine run?" No manufacturer has the answer.

Here, then, is a universal problem. *Get this important fact:* There is no machine which always operates at its highest efficiency at a fixed speed. In every production process, many factors are variable. There is no such thing as uniform material, constant temperature, constant humidity or constant moisture content. But all such variables can be compensated for by providing accurate speed control on the machine or process. Alert design engineers know these conditions and are including Lewellen Variable-Speed Controls as an integral part of their machines. Thus, the act of making production machines really efficient is not left to users. Illustrated on this page are only a few well-known machines which include Lewellen Variable-Speed Controls in their design.

Our engineers have had fifty years experience in the design and manufacture of variable-speed controls, and in assisting in the adoption of Lewellen Controls to every type machine and process. Lewellen Controls are available in a hundred standard types and sizes. Hundreds of special problems have been solved in order to meet machine dimensions and various machine conditions. *This is our business. We have no side lines.*

Production machines the country over now include more than 13,900 Lewellen Variable-Speed Controls. How is that for proof? We want to work with you. *Tell us your problem!*

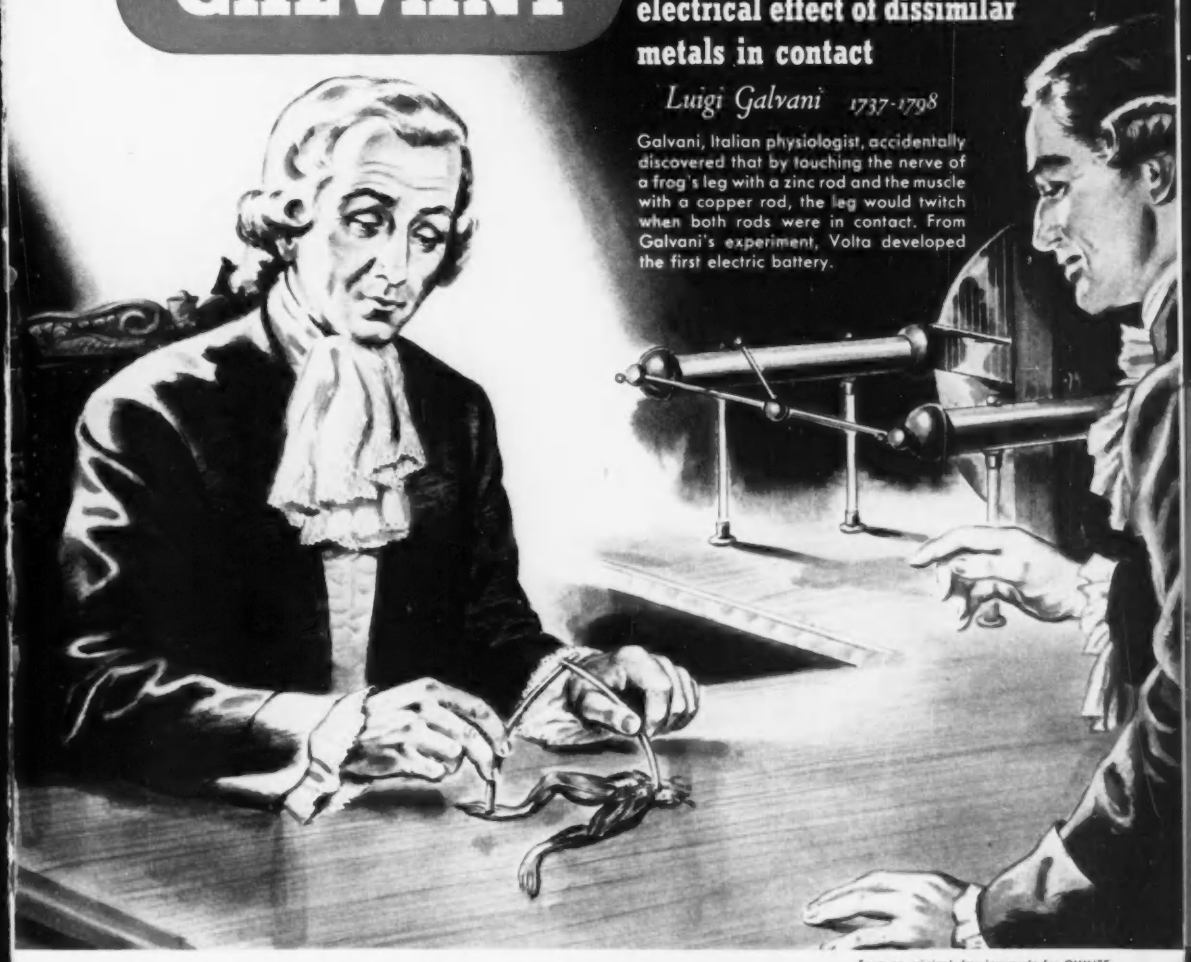
LEWELLEN MANUFACTURING CO., COLUMBUS, INDIANA

VARIABLE SPEED ENGINEERS

GALVANI ...FIRST to demonstrate the electrical effect of dissimilar metals in contact

Luigi Galvani 1737-1798

Galvani, Italian physiologist, accidentally discovered that by touching the nerve of a frog's leg with a zinc rod and the muscle with a copper rod, the leg would twitch when both rods were in contact. From Galvani's experiment, Volta developed the first electric battery.



From an original drawing made for OHMITE

OHMITE® ...FIRST in Tap Switches ...today

Be Right with

OHMITE

RHEOSTATS

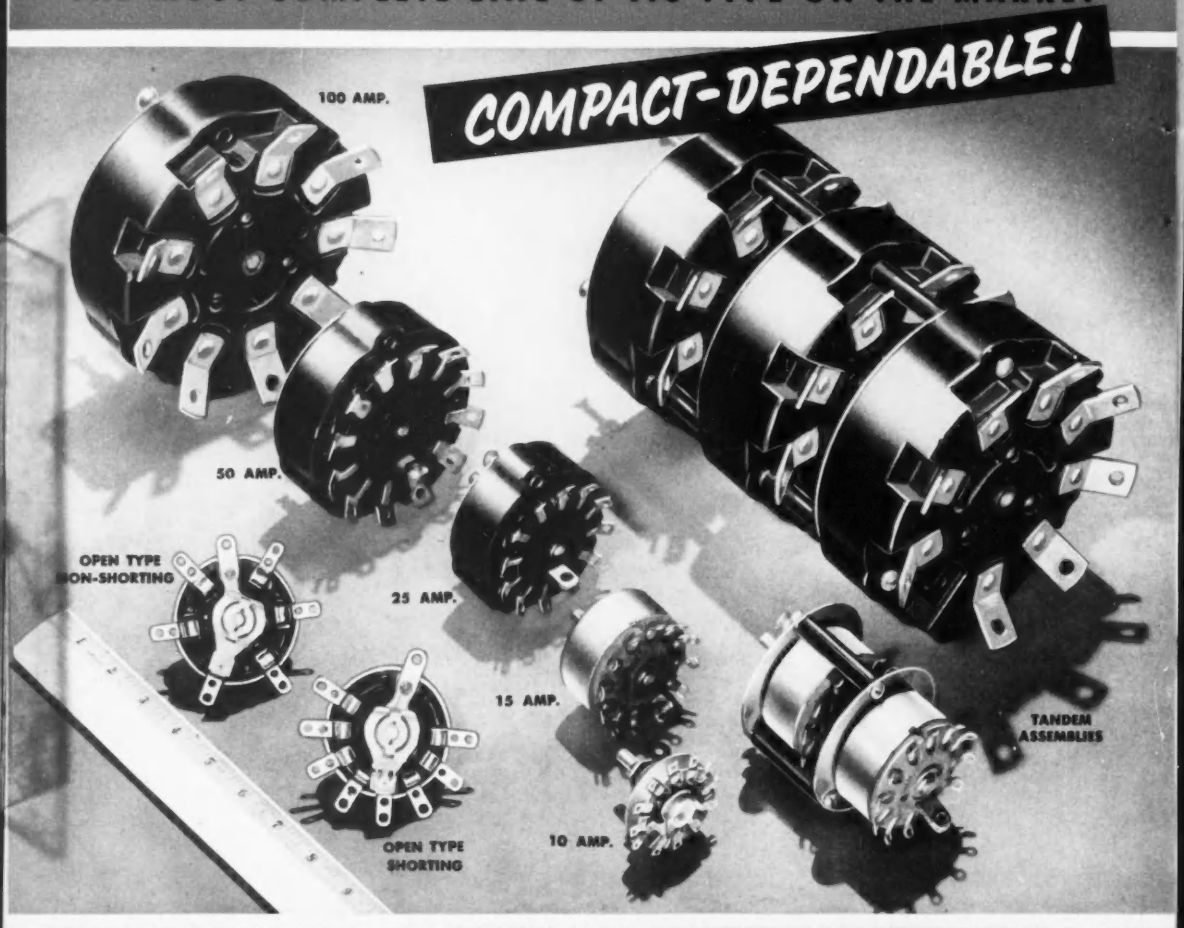
RESISTORS

TAP SWITCHES

In high-current, ceramic power-type tap switches, OHMITE leads the field. More manufacturers have standardized on these rugged tap switches than any other make on the market. The primary reason for this industry-wide preference for Ohmite tap switches is their compactness, permanent ceramic construction, and proven ability to give years of unfailing, trouble-free service. Available in ratings from 10 to 100 amperes a.c.

OHMITE *Rotary* TAP SWITCHES

THE MOST COMPLETE LINE OF ITS TYPE ON THE MARKET



If you need a compact, high-current, all-ceramic, power-type, rotary tap switch, investigate the Ohmite line. Ohmite tap switches are particularly designed for a-c use. They are available in the single-pole, non-shorting type with up to 12 taps. The self-cleaning, silver-to-silver contacts require no maintenance. The rugged, one-piece ceramic body is unaffected by arcing. Ratings range from 10 to 100 amperes a.c. Two or three of these switches can be grouped in tandem to form multi-pole assemblies. Ohmite tap switches are also available in open-type models for both shorting and non-shorting applications.

Write on Company Letterhead for Catalog and Engineering Manual No. 40.

OHMITE MANUFACTURING CO.
4830 Flournoy Street
Chicago 44, Ill.

Be Right with OHMITE

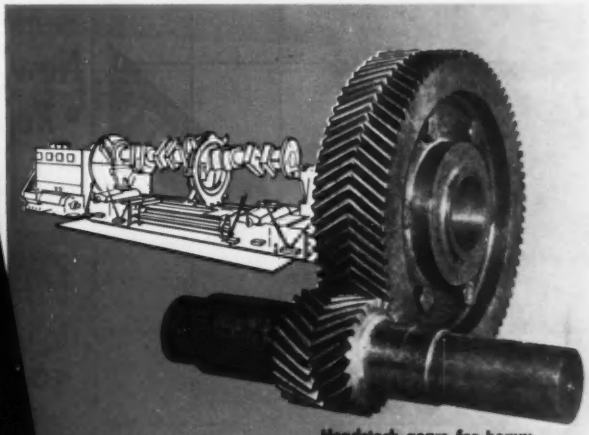
Reg. U. S. Pat. Off.

RHEOSTATS • RESISTORS • TAP SWITCHES

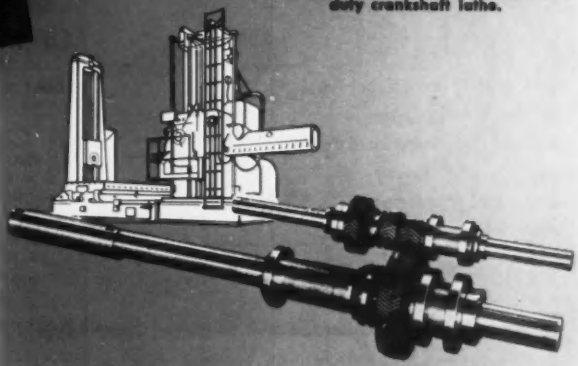
WHEN PRECISION IS VITAL

specify

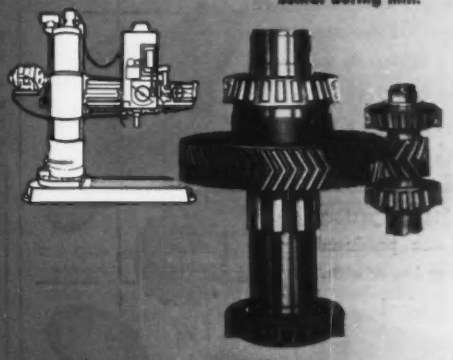
Farrel Gears



Headstock gears for heavy duty crankshaft lathe.



Gears for driving main and auxiliary spindles of a horizontal boring mill.



Spindle gears for a radial drill.

In many machine tools, *where accuracy is of primary importance,* Farrel herringbone gears are used to transmit a smooth, efficient flow of power to work or tool point.

The quiet, vibration-free performance and long life you can expect from these gears result from extreme accuracy of tooth spacing, contour and helix angle, and other qualities inherent in the Farrel-Sykes method of gear generation. They are made of the finest grade materials, in a complete range of sizes for any power capacity and any application.

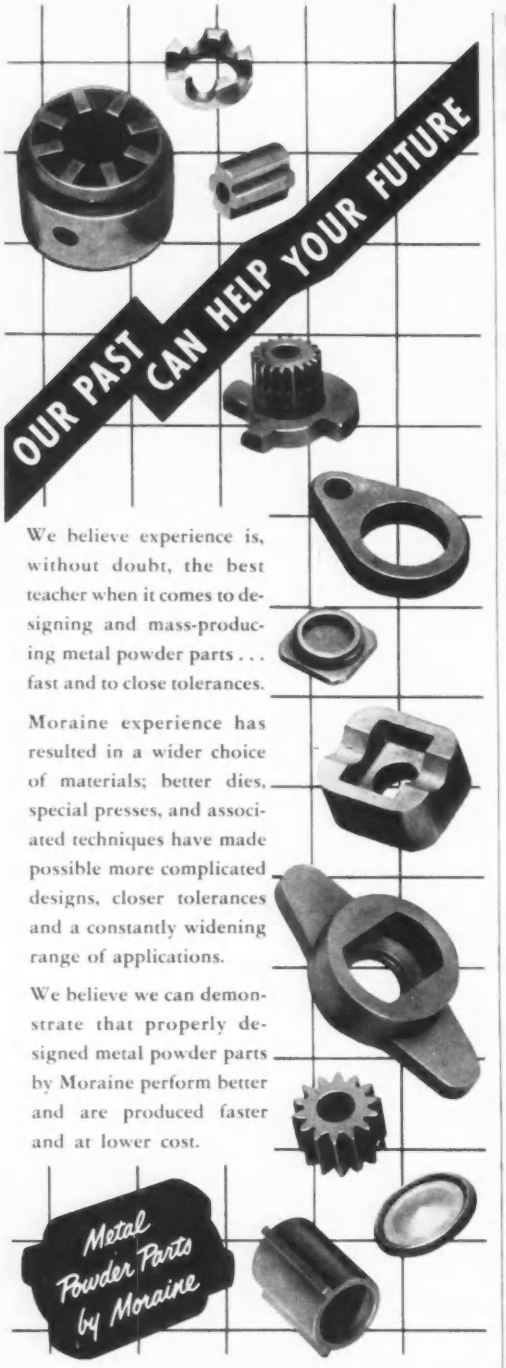
Wherever power transmission must be smooth and vibrationless under all conditions of load and speed, *specify Farrel herringbone gears.* Information and engineering assistance available, without obligation.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT

Plants: Ansonia and Derby, Conn., Buffalo, N. Y. *Sales Offices:* Ansonia, Buffalo, New York, Boston, Pittsburgh, Akron, Cleveland, Detroit, Chicago, Portland (Oregon), Los Angeles, Salt Lake City, Tulsa, Houston, New Orleans

Farrel-Birmingham

FB-69B



We believe experience is, without doubt, the best teacher when it comes to designing and mass-producing metal powder parts . . . fast and to close tolerances.

Moraine experience has resulted in a wider choice of materials; better dies, special presses, and associated techniques have made possible more complicated designs, closer tolerances and a constantly widening range of applications.

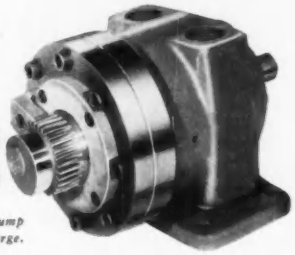
We believe we can demonstrate that properly designed metal powder parts by Moraine perform better and are produced faster and at lower cost.

MORAINE PRODUCTS

DIVISION OF GENERAL MOTORS, DAYTON, OHIO

New *HYDROPUMP* Permits
• *Regulating*
• *Reversing*
• *Stopping*
Oil Flow During Operation

NO VALVES . . . NO CHANGE IN SPEED OR DIRECTION OF ROTATION



(Right) Standard control pump mounted for vertical discharge.

This vane-type hydraulic pump provides positive displacement . . . but allows instant regulation of the volume and direction of oil flow to fit your individual circuit or cycle conditions. With the motor and pump operating continuously in one direction, you can:

1. Adjust the oil volume delivered to suit the job.
2. Vary the oil volume delivered at any part of the cycle.
3. Reverse the oil flow.
4. Completely stop the oil flow.

A small movement of the control will change the displacement of the pump or the direction of the discharge. This control may be used either as a simple volume adjustment or as an integral part of a cycle control system. Manual, automatic and remote control means are available. Ideal for hydraulic motor drives.

NO SPRINGS—NO VANE WEAR

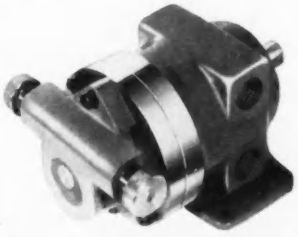
Vanes are positioned mechanically—no springs are employed. The pressure ring which contacts the vane tips rotates with the vanes, reducing friction and wear.

The *HYDROPUMP* is available in foot mounted, flange mounted and stripped models. Multiple ports and methods of mounting provide 16 possible connection combinations. Capacity 0 to 10 g.p.m. in either direction.

WRITE FOR ENGINEERING HELP AND LITERATURE

Ask for Bulletin 100-P. Submit your problems for recommendations. No obligation.

(Below) HYDROPUMP with micrometer volume control, mounted for horizontal discharge.



MILWAUKEE HYDROPOWER INC.

3445 N. 35th St. Milwaukee 16, Wis.

There's nothing like a TK ELECTRICAL HEATING ELEMENT

FOR DEFROSTING A REFRIGERATOR . .

DEGREASING MILITARY EQUIPMENT

and 1001 other jobs!

Where do you need heat? Clean, safe, easy-to-control electric heat? Heat that you can bend around corners, arrange into a pattern . . . or spot exactly where you want it?

Whatever the application, when you sit down to design the proper heating element to do the job, take advantage of the help available to you here at "heating headquarters". Sound advice on sheath metals, terminals, bending radii, etc., is yours for the asking.

We can save you time and trouble . . . guide you around pitfalls . . . help you improve your product. That's because we're specialists at engineering and controlling electric heat. Our men work at it every day . . . for many different manufacturers . . . of many different products.

You'll find TK* Heating Units in everything from irons to incubators, coffee makers to waffle bakers, griddles to gluepots.

And in the current defense build-up, we're proving again, as we proved in World War II, that we're equally at home with heating elements for guns, gun directors, boat galleys and a host of other aircraft, marine and submarine applications.

Our elements are long-lived, dependable. Let us help you design one for your job, and you'll agree: *there's nothing like a TK Electrical Heating Element!* For further information, send us your product blueprints—now.

*T. M. Reg. U. S. Pat. Off.

TK FERRO

TUTTLE and KIFT, INC.

A Subsidiary of Ferro Corporation

1830 N. MONITOR AVE. • CHICAGO 39, ILLINOIS

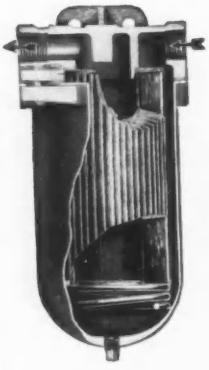
Bendix-Skinner

ORIGINATOR OF **MICRONIC** FILTRATION

Results Prove It

the *Finest* Name in Filtering

Nine times out of ten ***Bendix-Skinner*** Filters will supply the "finest" answer to your filtration problems. Here are the facts: available with patented, exclusive, resin impregnated cellulose elements; simple, quick replacement; high flow rate with minimum pressure loss; no channeling or bypassing; over 350 models providing filtration from ½ micron (.000019") upwards at flow rates from 1 to 5000 g.p.m. Why not let ***Bendix-Skinner*** filtration engineers work with you? Write us direct.



Model 3110-P filter element, 6⅛" x 3½", has a filtering area of 940 sq. in.!

SKINNER PURIFIERS DIVISION OF

1503 TROMBLY AVENUE,
DETROIT 11, MICHIGAN

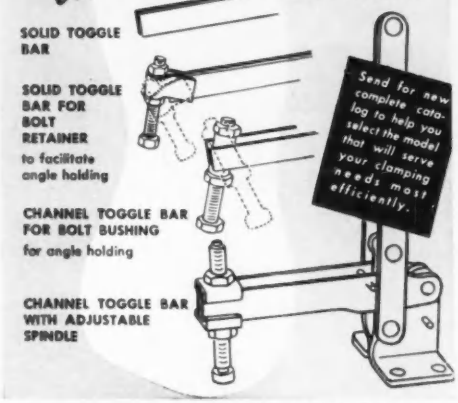
Bendix AVIATION CORPORATION

Export Sales: Bendix International Division, 72 Fifth Ave., N. Y. 11, N. Y.

KNU-VISE CLAMPS PROVIDE UNUSUAL VERSATILITY

What goes on here!

Toggle bars can be made adaptable for diverse applications—plain or with various end treatments to suit your job at hand.


SOLID TOGGLE BAR
SOLID TOGGLE BAR FOR BOLT RETAINER
to facilitate angle holding
CHANNEL TOGGLE BAR FOR BOLT BUSHING
for angle holding
CHANNEL TOGGLE BAR WITH ADJUSTABLE SPINDLE
Send for new complete catalog to help you select the model that will serve your clamping needs most efficiently.

Sales offices in principal cities

KNU-VISE PRODUCTS **LAPEER MFG. CO.**

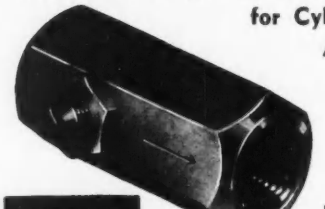
3057 DAVISON ROAD • LAPEER, MICHIGAN

WESTERN DIVISION: 422 MAGNOLIA ST. GLENDALE, CALIF.

FLOW CONTROL VALVE

for Cylinder Speed Adjustments

OVER A **WIDE RANGE** IN AIR OR HYDRAULIC USE



The Pneu-Trol Flow Control Valve combines an efficient Stainless Steel FLOATING BALL CHECK which opens and closes at the slightest change in flow direction, with a Vernier Type VARIABLE NEEDLE ORIFICE adjustment in a compact control which has widened air and hydraulic cylinder application by providing precise control of cylinder action. Modifications of the Pneu-Trol Valve are available as: Plain Check, check with Fixed Orifice (orifice drilled by customer in the Standard Check Valve), Needle Valve and Velocity Limiting Check, as illustrated at left. All Pneu-Trol Valves are made from bar stock in brass (up to 1000 psi) or steel (5000 psi) or other body metals to your specifications. All internal parts are Stainless. All valves available in 5 sizes—⅛", ¼", ⅜", ½" and ¾".

Attractive prices — immediate delivery.

Write for illustrated circular and price list.

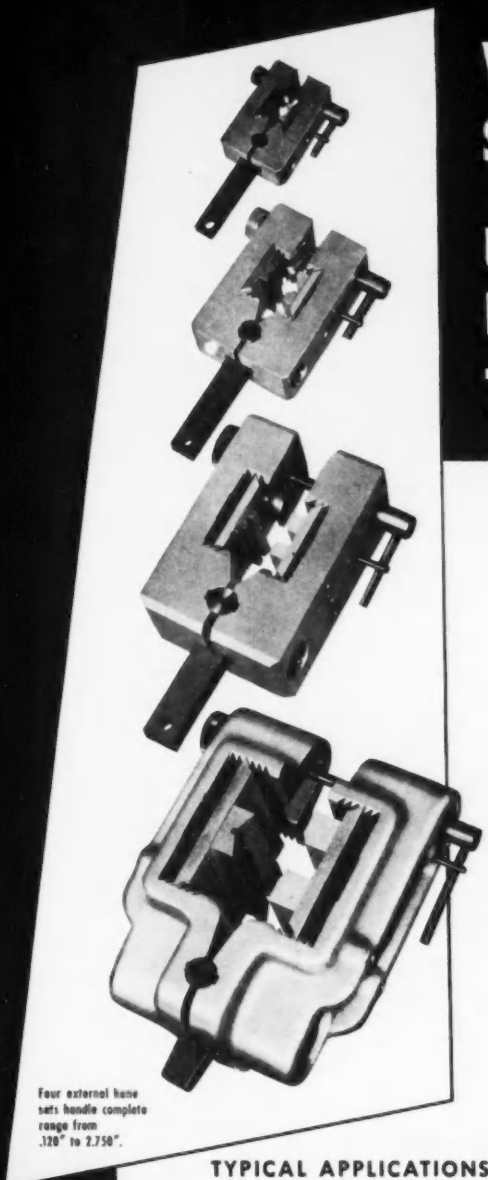
WRITE

Pneu-Trol Devices, Inc.

1428 N. Keating Ave., Chicago, Ill.

When O.D.'s Have to be Straight and Round,

Use SUNNEN EXTERNAL HONES To Correct Defects



Four external hone sets handle complete range from .120" to 2.750".

For shafts, pins, arbors, gage bars, plungers, metering rods, spindles, valve pistons and similar parts

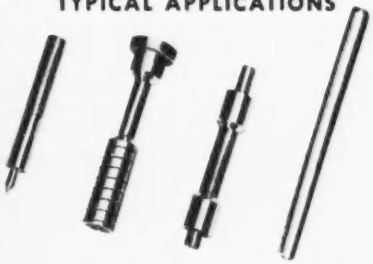
These new honing tools correct heat treat warpage and waviness—can be used with multiple stone holders to increase the length of the honing surface, to bridge the curvature of the part and produce a straight, round outside surface. And besides correcting such geometric defects as warpage and out-of-roundness, Sunnen External Hones also remove defects in surface finish—for example, centerless grind patterns and tool marks—with minimum stock removal.

Sunnen External Hones are suitable for finishing most types of outside surfaces in a diameter range of .120" to 2.750". They hold dimensional tolerance to .0001" and better; produce surface finish as fine as 2 micro-inches RMS in hardened steel. Speed is many times faster than lapping.

Production, tool room, maintenance, salvage—any or all of these departments may have need for Sunnen External Hones. To find out more about the benefits, mail the coupon for FREE descriptive booklet.

634

TYPICAL APPLICATIONS



Needle Valve Metering Rod Valve Spool Gage Bar

SUNNEN PRODUCTS COMPANY
7976 Manchester Avenue • St. Louis 17, Missouri
Canadian Factory: Chatham, Ontario

To: SUNNEN PRODUCTS CO.
7976 Manchester Ave., St. Louis 17, Mo.

☐ Please send bulletin on external honing. ☐ Have representative call.

Name.....

Company.....

Address.....

City .....Zone.....State.....

bearing for bearing, size for size...

BEARINGS	McGILL No. GRI-209	BRAND A* BEARINGS	BRAND B* BEARINGS	BRAND C* BEARINGS	BRAND D* BEARINGS
PUBLISHED LOAD RATINGS	8370 POUNDS	5370 POUNDS	6060 POUNDS	3250 POUNDS	4610 POUNDS

*Nationally known bearings that are dimensionally equivalent.

McGILL® GUIDEROL (Trade Mark) BEARINGS

HAVE AT LEAST 38% greater load capacity

Here's proof that you get more load carrying capacity when you buy McGill Guiderol Bearings. The chart above was computed from published cataloged ratings on the basis of 2,500 hours average life expectancy at 100 R.P.M. for retainer type cylindrical roller bearings dimensionally equivalent to the McGill Guiderol Bearing No. GRI-209.

The load capacity of the Guiderol Bearing ranges from 38% to over 100% greater than any of the retainer cylindrical type roller bearings with which it will interchange dimensionally.

A Guiderol Bearing at least one size smaller can often be substituted and the shaft and housing requirements reduced in size and cost.

The Guiderol Bearing has greater load capacity because it embodies a new principle of construction using guided rollers. This eliminates the need for space wasting cages, thus a full compliment of rollers can be used for greater load support. It also overcomes skewing tendencies and internal looseness. Consider the savings you can make using Guiderol Bearings. Write for your copy of Bulletin GR-50 today.

GUIDED ROLLERS PREVENT SKEWING — BINDING

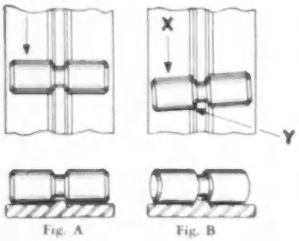


Fig. A Fig. B

A guide rail on the inside diameter of the outer race maintains roller alignment. Normally no correction is required. Should misalignment cause tendency to skew, the guide rail touches grooved rollers back into position by momentary contact at Y. X indicates direction of roller rotation.

Bulletin GR-50 lists proposed standard sizes in CT Series (interchangeable with cylindrical type dimensions) for MT Series (interchangeable with ordinary needle type dimensions). Write McGill Manufacturing Co., Inc., 201 No. Lafayette St., Valparaiso, Indiana for your copy.

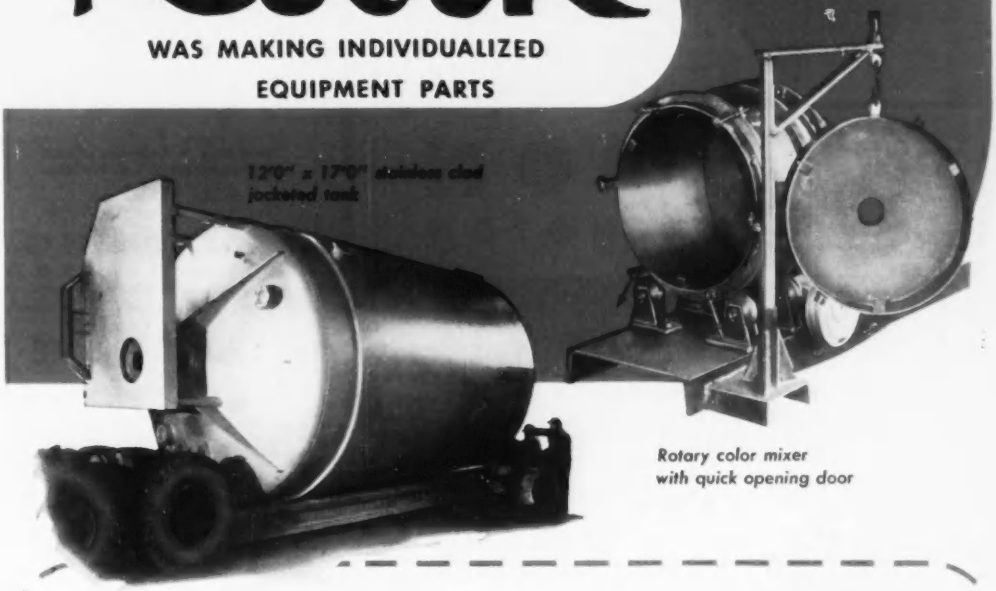
McGILL® precision bearings

BACK IN THE 1880's

WHEN THE FIRST WELDING MACHINE WAS INVENTED

Koven

WAS MAKING INDIVIDUALIZED EQUIPMENT PARTS



Rotary color mixer with quick opening door

In that era of many sceptics, KOVEN, along with men of faith and vision, helped to pioneer the virgin fields of American industry.

To today's era of modern design, KOVEN brings over 70 years of experience-tested techniques in the production of Individualized Equipment Parts. That's why manufacturers cross-country lean on KOVEN for parts precisely tailored to their every need. Dollar-wise, they have found that our expert facilities and craftsmen so frequently enable us to build a part more efficiently and cheaply than they themselves can. A KOVEN representative will be pleased to visit your offices and discuss your production problems. Write or call for a consultation—no obligation.

Our complete modern facilities include: Machine, welding, plate and sheet metal, galvanizing and painting shops. X-ray inspection insures quality control in every KOVEN Individualized Equipment Part.

L. O. KOVEN & BRO., INC.
154 Ogden Ave., Jersey City 7, N.J.

Plants:
Jersey City, N. J.

Dover, N. J.

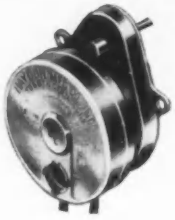
KOVEN FOR INDIVIDUALIZED EQUIPMENT PARTS SINCE 1881

TIMING MOTORS

For Industrial - Military - Commercial Uses

1600 SERIES:
LOW COST VERSATILITY

Specifically designed as a standard component for the widest possible range of timing applications with 17 standard speeds from 60 rpm to 1 revolution per hour.



4400 SERIES:
SLOW YET COMPACT

Designed for small size and low cost in applications requiring slower speeds from 6 hours to 7 days per revolution.

HAYDON
AT TORRINGTON

HEADQUARTERS FOR
TIMING

3100 SERIES:
HEAVY DUTY DEPENDABILITY

For control and instrument applications that require a heavy duty train and speeds from 1 hour to 14 days per revolution.

COMPLETE SPECIFICATIONS

Literature giving complete design and engineering specifications will be sent on request. Ask for the catalog which best suits your need.

TIMING MOTORS - TIMING DEVICES - CLOCK MOVEMENTS

Write for whichever catalog you need

HAYDON Manufacturing Co., Inc.
SUBSIDIARY OF GENERAL TIME CORPORATION

3135 ELM STREET
TORRINGTON, CONNECTICUT

IMMEDIATE CAPACITY FOR DEFENSE SUB-CONTRACTS

STRAIGHTENING & CUTTING
Perfect straight lengths to 12 ft.
.0015 to .125 diameter

WIRE FORMS
.0015 to .080 diameter

SMALL METAL STAMPINGS
.0025 to .035 thickness
.062 to 3 inches wide

★

Specializing in Production of Parts for Electronic and Cathode Ray Tubes

Write for Illustrated Folder
Send Blueprints or Samples for Estimate

ART WIRE & STAMPING CO.
227 High Street Newark 2, N. J.

HARD CHROME PLATING

25,000 Amp. Generator capable of handling

Lengths up to 62 feet long

• • •

SMALL PARTS A SPECIALTY

• • •

ANODIZING COMPLETELY EQUIPPED

Government Specifications

PROMPT AND GUARANTEED SERVICE

HARDCHROMERS, INC.
Krick Road Bedford, Ohio
Telephone Bedford 2-1500

Conformability

THE tolerance of adjustment to loading or misalignment is known as conformability. If a bearing could be kept in perfect alignment with the shaft it supports and if an oil film could be maintained at all times, there would be no need for more than one bearing material. This ideal bearing material would be hard so that it would resist changes in load that would be expected in normal machine operations, whether these be starting loads, firing loads or loads due to work of the machine.

Actually it is well known that perfect alignment is seldom attained. Tolerances alone, if they are all in an unfavorable direction, can add up to slight misalignment. The tolerance in location of a hole, plus the tolerance of the bore, plus the tolerance of the bearing wall, plus the tolerance of the shaft, presents a difficult problem for the design engineer.

Part of the problem is solved by selection of a proper bearing material. Advantage is taken of a different kind of tolerance—a tolerance of the bearing material to move and adjust itself to unfavorable loading or to slight misalignment.

Conformability is also very important if the oil film is broken and perfect lubrication is lost for a short period. As soon as the oil film is broken the local bearing area starts to heat and local dimensions change. If the material is conformable it will move to better support the load. Then when the oil film is reestablished the bearing will run cooler than before. These are some of the changes that take place during break-in and explain why a bearing will change and even show signs of distress in the first few hours of running and yet run many hundreds and even thousands of hours with little change after break-in.

In general, soft materials conform so that conformability is an inverse function of hardness and is thus best in the babbitts. Unfortunately if a material is too soft, it will move under high loads and the properties of conformability must come to a compromise with the properties of load carrying capacity and fatigue resistance which are associated more with hard materials than soft materials. A compromise for this situation is to use a thin layer of a soft babbitt on a harder backing such as bronze or steel. Then the harder backing will carry the load while the thin babbitt will furnish desirable bearing properties and yet carry higher loads due to its thinness.

For higher loads bronze on steel is used. Conformability is sacrificed at the expense of gain in load carrying capacity with the necessity of design for more ideal conditions for bearing operation.

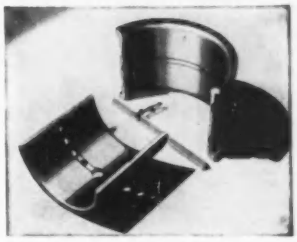
In the use of steel backed bearings, conformability is lost because the steel has less ability to conform compared to the bearing materials used at the running surface. If the lining material is soft it will conform, but if it must be thin conformability is limited.

Relative Comparison of Conformability

Relative properties of bearings based on wide bearing experience showing relative conformability and tolerance to scoring at expense of low fatigue resistance and low load carrying capacity. The relative position of a bearing material will change from this generalization with the composition of the alloy, for instance the amount of lead in a leaded bronze. It will also change remarkably with the thickness of babbitt on a backing material.

SOFT MATERIALS
High Conformability
Low Tendency to Score
Low Load
Low Fatigue Life

HARD MATERIALS
Low Conformability
High Tendency to Score
High Load
High Fatigue Life



Babbitt lined bronze is an ideal combination for both load carrying capacity and conformability.

If a bearing such as solid bronze is subject to a deforming load, the bronze will move, not only at the bearing surface but at the back. The whole bearing will move. The surface will conform to the new shaft position, the back will seat itself more properly and the bearing as a whole will assume a proper running position.

A bearing cannot be selected on the basis of one desirable property. If very high loads are required fatigue resistance and load carrying capacity take precedent. If corrosive conditions are encountered the selection of alloys is limited. The proper bearing material must be selected to best fit the operating conditions.

Engineering Service

Johnson Bronze offers manufacturers of all types of equipment a complete engineering and metallurgical service. We can help you determine the exact type of bearing that will give you the greatest amount of service for the longest period of time. We can show you how to design your bearings so that they can be produced in the most economical manner. As we manufacture all types of Sleeve Bearings, we base all of our recommendations on facts free from prejudice. Why not take full advantage of this free service?

•

This bearing sheet data is but one of a series. You can get the complete set by writing to—

Johnson Bronze

SLEEVE BEARING HEADQUARTERS
508 S. MILL ST. • NEW CASTLE, PENNA.

Engineering data

Complete, concise, practical . . . dealing with the application of SYNCHRON timing motors, time machines, gear trains, and D.C. motors for special timing jobs.

to help you

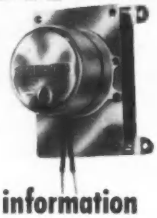
solve your timing problems . . . adapting standard timing machines or designing new.

design for defense

Hansen D. C. Motors powered Servo units in last World War. Improved products . . . enlarged design and manufacturing facilities for precision production . . . available for defense contracts.

SYNCHRON timing motors

Pulls up to 8 oz. direct load at 1 R.P.M. Operates efficiently at −40° to +140°F. Available with gear trains to convert any speed.



Send for complete information

HANSEN MANUFACTURING CO., INC., Princeton 5, Ind.

Send catalog and engineering data to:

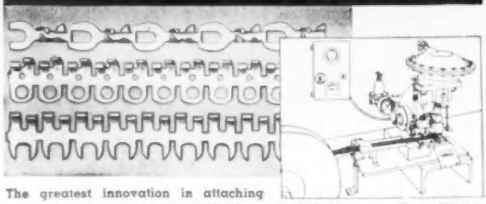
Name .....

Firm .....

Address .....

City ..... Zone ..... State .....

Now Terminals Can Be ATTACHED & SOLDERED *in ONE Automatic Operation!*



The greatest innovation in attaching terminals to wires is now available to the industry . . . "Pre-soldered" TANDEM TERMINALS! Made in various sizes and types, these remarkable, production-proved terminals (supplied on reels) can be applied at rates up to 1200 per hour by a new Terminal Attaching Machine that cuts off, clinches and solders terminals in one instantaneous operation. Handling of loose terminals, solder and flux are eliminated to reduce costs and boost production on long runs. Standard types available. Send for detailed information, enclose sample of wire and terminal now used. Address Dept. E.

For ordinary runs in moderate quantity we continue to produce

SEPARATE TERMINALS for ELECTRIC WIRES

We also make SMALL METAL STAMPINGS Exact to Customer's Prints. Modern Plant and Equipment. Moderate Die Charges. Precision Work Prompt Service.

PATTON-MacGUYER COMPANY
Edgewood Station Providence 5, R.I.

Where might is measured in millionths of an inch

Behind its striking power lie incredibly precise instruments and fire control devices. Here, at the heart of a modern warship's might, you're likely to find Micro precision ground ball bearings — tiny miniatures in sizes as small as ⅛" O.D. and with certain tolerances held to within 25 millionths of an inch.

In America, only Micro makes such bearings. Because they are *fully ground* they assure trueness of dimensions, higher capacity and lower friction than is possible by other methods. Yet Micro bearings actually cost less.

If extreme refinement in size, weight and efficiency are your objectives, investigate the advantages offered by Micro bearings.

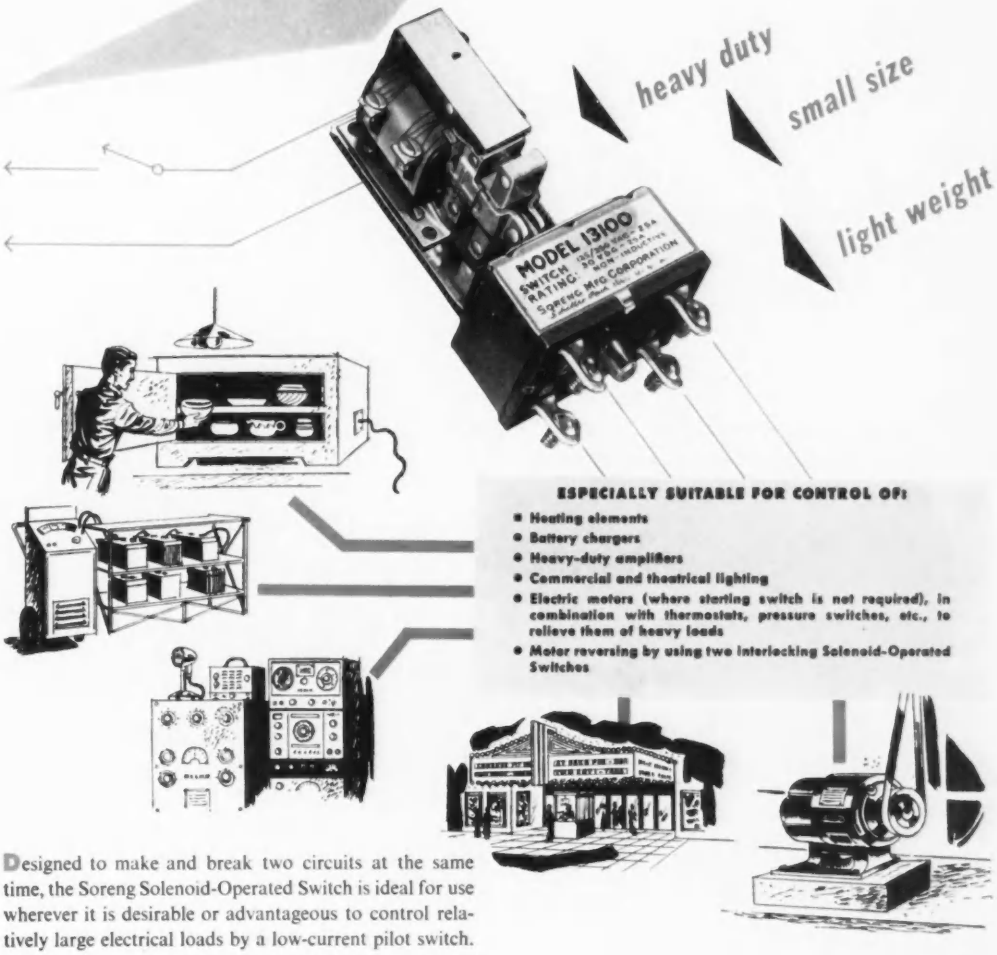
Write today for Technical Bulletin No. 50

MICRO

New Hampshire **Ball Bearings, Inc.**

3 Main Street, Peterborough, N. H.

check the advantages of this Soreng
SOLENOID-OPERATED SWITCH



ESPECIALLY SUITABLE FOR CONTROL OF:

- Heating elements
- Battery chargers
- Heavy-duty amplifiers
- Commercial and theatrical lighting
- Electric motors (where starting switch is not required), in combination with thermostats, pressure switches, etc., to relieve them of heavy loads
- Motor reversing by using two interlocking Solenoid-Operated Switches

Designed to make and break two circuits at the same time, the Soreng Solenoid-Operated Switch is ideal for use wherever it is desirable or advantageous to control relatively large electrical loads by a low-current pilot switch.

The unit is compact and light in weight—consisting of a totally enclosed, normally open DPST switch, actuated by a Soreng TT type Solenoid.

Switching member is rated 25a at 125/250v a-c (resistive load); 25a at 30v d-c. Solenoid actuator can be furnished to operate on any a-c voltage between 24 and 220, 50 to 60 cycles.

Specialists In Electrical Specialties

Want more information? Write, without obligation, for Bulletin N111.

SORENG MANUFACTURING CORPORATION

9555 Eden Ave., Schiller Park, Ill. (Chicago Suburb)
Plants: Schiller Park, Ill. • Fremont, Ohio

There is only *one* PENTRATE . . . the oldest name in black oxide finishing. Since 1923, it has stood as the leader in uniformity, dependability and quality. Discerning metal finishers have used over *twelve million* pounds. This label is your assurance of reliability and continuous research for an even better product – insist on it!

Pentrate meets U. S. Gov. Spec. 57-0-2, Type III, Class A.

HEATBATH CORPORATION

•

SPRINGFIELD 1, MASSACHUSETTS

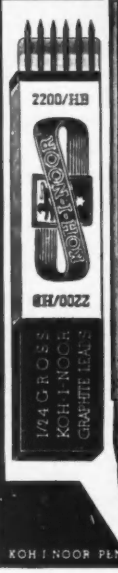
Precision is the Keynote—in Production and Performance

The word precision perfectly characterizes every relay manufactured by LEACH, and this precision is most apparent in their performance. Whatever the purpose, LEACH can provide relays of advanced design for flexibility, economy and unexcelled performance. Highest standards of engineering, materials and workmanship. For better controls through better relays—contact LEACH.

LEACH RELAY CO.

5915 AVALON BOULEVARD, LOS ANGELES 3, CALIF.
Representatives in Principal Cities of U. S. and Canada

KOH-I-NOOR
LEADS & HOLDERS



2200 Koh-I-Noor Graphite Leads
17 Degrees of Accurate Grading
Recognized by Draftsmen the World Over for Dependable Service
Packed Six of a Degree in a Protective box
Smoothness, Strength, Uniformity combined with long lasting qualities

AND NOW

2200 KOH-I-NOOR FLEXICOLOR LEADS

"The Lead That is Really Flexible"
UNSURPASSED BREAKING STRENGTH
SEVEN COLORS AND COMBINATION OF RED AND BLUE — RED AND YELLOW

★

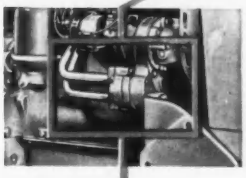
All the above leads for use in 1504, 1511, 5611 or 5612 Holders

By the Makers of The Famous KOH-I-NOOR DRAWING PENCILS

KOH-I-NOOR PENCIL COMPANY, INC. BLOOMSBURY, NEW JERSEY

PESCO HYDRAULIC POWER

ON FARMALL SUPER C TOO!



Small, compact, weighing only 3 lbs. Pesco hydraulic pump Model 051012 operates at 1200 psi and will pump 4½ gal. per minute at 2800 rpm.

For rugged, dependable duty in the fields, the powerful Farmall Super C tractor is equipped with a Pesco hydraulic pump. This pump powers the hydraulic system that gives complete finger-tip control of the tillage tools . . . control that makes farm work easier . . . lessens time spent in the fields. International Harvester uses smooth Pesco hydraulic power to do the heavy work on Farmall Cub, Super A and Super C. This is because Pesco hydraulic engineers have developed hydraulic pumps that give top-flight performance with little or no maintenance.

Perhaps Pesco equipment can help your products give the dependable service that wins customer loyalty. Why not write today for full information?

engineering Pesco production

PRODUCTS DIVISION

BORG-WARNER CORPORATION

24700 NORTH MILES ROAD BEDFORD, OHIO

As sure as the coming of Spring

...you will switch to MOLYBDENUM High Speed Steel

The increased usage of Molybdenum high speed steel is based on:

its merits,
its easy availability,
its lower cost.

You can save tungsten for uses where it is really needed. Don't delay, the switch is easy.

All the facts you need in this FREE BOOKLET.

Climax Molybdenum Company
500 Fifth Avenue · New York City

Please send your FREE BOOKLET
"MOLYBDENUM HIGH SPEED STEELS"

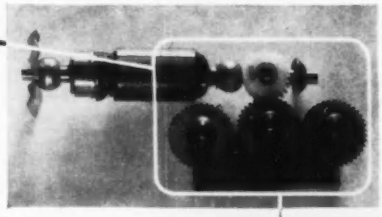
Name .....
Position .....
Company .....
Address .....

PE-11

MOLY

Mass. Gears

Applied in Home Electric Mixer

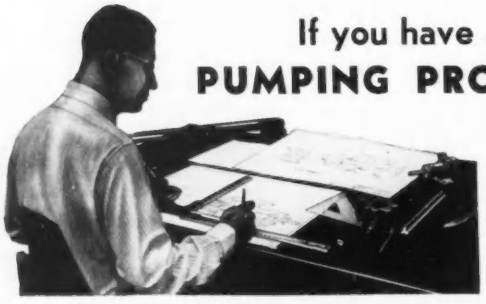


General Electric uses "Mass. Gears" in their home electric mixer as shown in illustration. Smooth quiet operation of this mixer as well as long life and freedom from attention can largely be attributed to the precision of the gears and the careful selection of the materials from which they are produced.

This typical example of "Mass. Gear" workmanship is one of many instances where our gears are giving outstanding performances in the products of nationally-known manufacturers.

Consult "Mass. Gear" on your problems. Address: Massachusetts Gear & Tool Co., Woburn, Mass.

Massachusetts Gear & Tool Co.
Woburn, Mass.



If you have a
PUMPING PROBLEM

ASK FOR

VIKING PUMP ENGINEERING

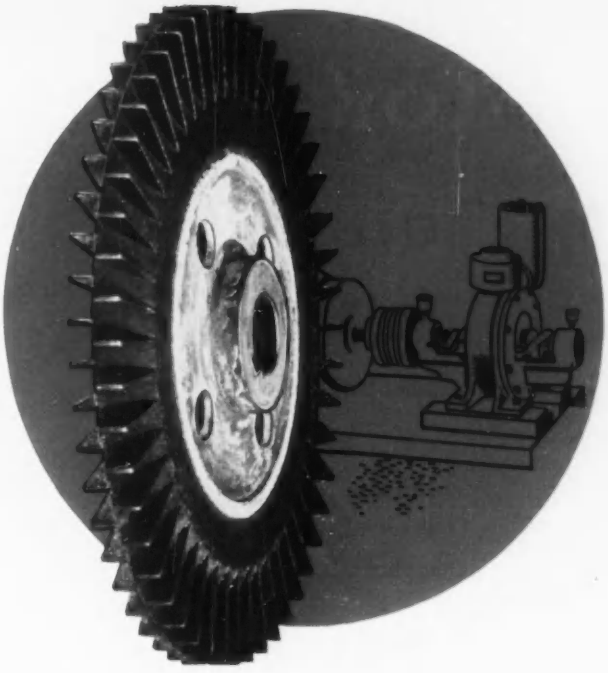
You'll find Viking engineers don't need to compromise on size or style of Rotary pump to fit your needs. Probably there is one ready to adapt to your problem. They have a wealth of experience to draw from to help solve your pumping problems. Forty years of building, designing and applying Viking's gear-within-a-gear principle has developed the most complete line of all rotary pumps and it places them in a position to solve your pumping problem best.

Ask Viking for the answer to your pumping needs. Send for free bulletin 51 SX today.

VIKING
AN HONORED NAME IN PUMPING

See Our Catalog in SWEETS

Viking PUMP COMPANY
Cedar Falls, Iowa



Found:

The 2% that cured a Pickled Pump

How years of N-B-M Metallurgical experience paid off by solving a severe problem of corrosion

When a vinegar producer suddenly starts having frequent pump failures due to extreme impeller corrosion, it's pretty evident that something unusual is going on . . . particularly when the same pump had been used successfully for years. The pump manufacturer sent an engineer to the installation . . . and found that *concentrated* vinegar was being pumped, instead of *diluted* vinegar as before. Impellers in some cases were lasting only 1 week.

The pump manufacturer came to us with the facts—and our Metallurgical Department was immediately put to work on the problem.

Result? **In a matter of days, impellers of a new alloy were on their way with a slight but important alloy change . . . the addition of 2% nickel. These impellers now last 18 months to 2 years—longer than they ever had before!**

We're proud of examples like this . . . because they show how effectively our facilities for Research and Engineering — combined with 75 years of practical application experience—make money-saving solutions to problems on . . .

Non-Ferrous Bearings and Castings—
As-Cast or Machined

Bronze Bars—
As-Cast or Machined;
Cored, Solid, Hexagon

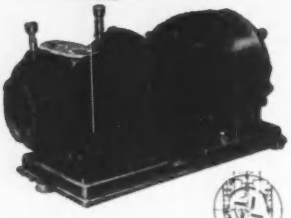
Babbitt Metals—
For every type of
bearing service

AMERICAN **Brake Shoe** COMPANY

NATIONAL BEARING DIVISION
4932 Manchester Avenue • St. Louis 10, Mo.

PLANTS IN: ST. LOUIS, MO. • MEADVILLE, PA. • NILES, OHIO • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

NEW KRAISSL AIR PUMPS for SUCTION and PRESSURE



Eliminate Oil Vapors from Discharged Air

The new Kraissl Class 23 pumps completely eliminate undesirable oil vapors from discharged air. In many operations, this means a tremendous saving to you—in time, materials and industrial health. Pumps are dry lubricated—displacement blades take up their own wear. Positive, fan-cooling for continuous high performance. Available with double extended shaft for group installation from single power source. Performance data: 1750 RPM, but not limited to this speed. Capacities from 5 cfm—20 cfm, for single units; larger capacities by group drive.

Kraissl Class 23 pumps are specifically designed for all packaging and printing machinery; and similar applications where air pressure or suction, without discharge oil, is preferable.

- Suction feed or pick-up of paper, cardboard, tin, etc.
- Container-filling: bags, bottles, tubes, etc.
- Automatic handling on conveyor systems
- Packing in shipping crates and cases
- Printing presses and vacuum printing frames
- Vacuum canning machines
- Vacuum holding chucks
- Ideal for handling food products, beverages, pharmaceutical preparations—where rigid sanitation standards are mandatory.

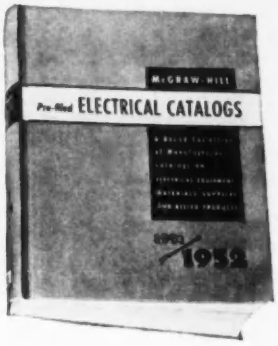
FREE

Write today for our new Bulletin A-1399 on Class 23 Air Pumps.

Kraissl Co. Hackensack, N. J.
Please send your bulletin A-1399
Name_____
Company_____
Address_____
City_____ State_____

KRAISSL CO. Inc.
310 Williams Ave., Hackensack, N. J.

MORE COMPLETE!
MORE USEABLE!
Your **NEW**
Electrical
Catalogs
are being distributed...



This unit, especially compiled for Product Engineers, is full of useful, up-to-date electrical product data for the highly important Original Equipment Market.

If it's *electrical* — make this your first source of information on **"Who", "Which"** and **"Where"** — it will save your time. *Get the ELECTRICAL CATALOGS habit . . . today!*

If not available at your plant, write to: Distribution Manager, McGraw-Hill Catalog Service. There is no charge to qualified users.

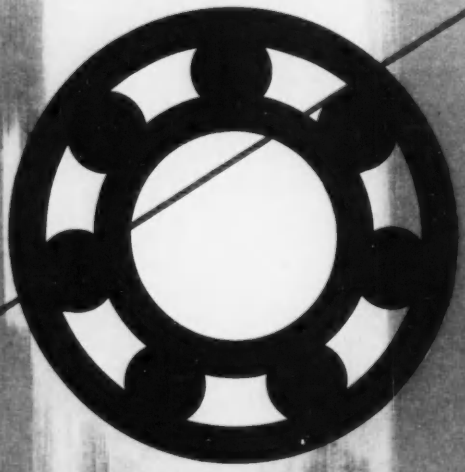
McGRAW-HILL PRE-FILED Electrical Catalogs

a Specific Market Unit of:

McGraw-Hill Catalog Service
330 W. 42ND STREET
NEW YORK 18, N.Y.

SELF-LUBRICATED FOR Normal LIFE

Lubriflush



FOR Longest LIFE

U. S. MOTORS

(See next page)

U.S. MOTORS

SELF-LUBRICATED *for normal life*

plus LUBRIFLUSH *for longest life*

Far Superior to Ordinary Lubrication

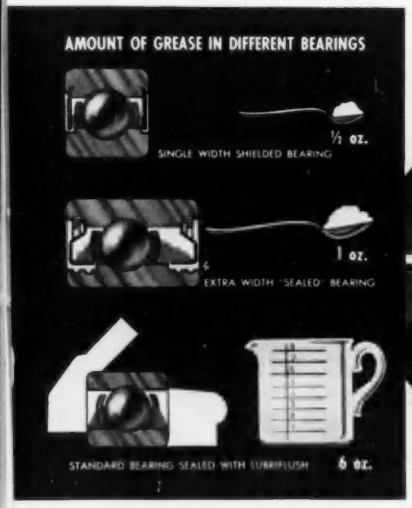
When bearing grease fails, any bearing can fail. Life of a bearing depends upon the effectiveness of the lubricant. As long as the proper grease is uncontaminated by acid, dirt, dust and flakings, bearings are long lasting. But no pre-lubricated bearing is 100% sealed, and the lubricant will deteriorate. Bearings breathe; they eventually become contaminated. Now, with Lubriflush, bearings are fully grease-sealed to eliminate contamination under normal operation. When severe conditions require re-lubrication for longest life, Lubriflush automatically purges and renews the lubricant, therefore prolonging bearing life.

ORDINARY BEARING REGREASED
No convenient way is provided for completely flushing the old worn-out grease in the dead end area behind the bearing.

Other U. S. Motors features

- **Asbestos-Protected Windings**
- **Normalized Castings**
- **Annealed Steel Laminations**
- **Streamlined, Shielded Housings**
- **Solid Centricast Rotors**
- **Dual Cyclone Ventilation**
- **Deep-Groove Ball Bearings**
- **Factory-Exchange Stators**

LUBRIFLUSH BEARING BEFORE REGREASING
To renew lubricant remove drain plug and apply grease gun to fill fitting. All of the devitalized grease is replaced.



12 times more lubricant volume

Note in above drawing the increased lubricant capacity of U. S. Lubriflush bearings—actually 12 times the volume of grease used in a standard shielded bearing.

Lubriflush
AT NO EXTRA COST

Request Lubriflush Bulletin 1549 and Complete Line Bulletin 1543

POSITIVE, COMPLETE RE-LUBRICATION
Fresh lubricant, passing through bearing, flushes chamber. A complete re-lubrication is quickly and safely accomplished.

U.S. ELECTRICAL MOTORS Inc.

PACIFIC PLANT: Los Angeles 54, California ATLANTIC PLANT: Milford, Connecticut

Atlanta 3, Ga.; Bakersfield, Calif.; Boston 16, Mass.; Chicago 8, Ill.; Cincinnati 16, Ohio; Cleveland 14, Ohio; Dallas 9, Texas; Detroit 2, Mich.; Fresno 1, Calif.; Houston 4, Texas; Indianapolis 4, Ind.; Milwaukee 2, Wisc.; Minneapolis 2, Minn.; New York City 6, N. Y.; Philadelphia 2, Pa.; Pittsburgh 2, Pa.; San Francisco 7, Calif.; Seattle 4, Wash. *Distributors and Agents in all principal cities.*

HOW ENGINEERS USE GLASS TO *prevent* SERIOUS FIRES

To get fires under control faster, regardless of variations in operating requirements, Grinnell engineers developed a positive, fast-opening sprinkler head. Here's how a specially designed glass by Corning helped solve their problem.

In the Grinnell Sprinkler Head shown above, heat causes the liquid in the "Quartzoid"* to expand, breaking the bulb, opening the head . . . and sending the sprinkler system into action much faster than is possible with solder type heads. The bulb is made to shatter at temperatures as low as 135° F. The temperature at which the sprinkler system goes into action depends on the amount of liquid in the bulb and the strict specifications to which Corning produces this glass.

Air lines and defects are eliminated to maintain uniform strength. Wall thickness is drawn to the closest tolerances to assure uniform breakage. Glass also eliminates corrosion, another factor which might interfere with operation.

Glass has many other industrial uses. Are you developing a new product, or faced with a material shortage? You'll find that Corning has the experience, the technical skills and manufacturing facilities to produce glass that may do a better job than existing materials.

*Reg. T.M. of Grinnell Co., Inc.

PYREX

CORNING GLASS WORKS

CORNING, NEW YORK

Corning means research in Glass

1851 • 100 YEARS OF MAKING GLASS BETTER AND MORE USEFUL • 1951

Technical Products Division: Laboratory Glassware, Signalware, Glass Pipe, Gauge Glasses, Lightingware, Optical Glass, Glass Components

GLASS IS AVAILABLE NOW—ECONOMICAL, TOO

CORNING GLASS WORKS, Dept. PE-11, Corning, N. Y.

Please send me your "Designers Bulletin IZ-1."

Name _____ Title _____

Company _____

Address _____

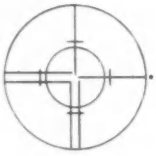
City _____ Zone ____ State _____

Custom-made Optical Reticles

...IN ANY DESIGN

Now Available in Quantity from

EXPANDED FACILITIES OF W. & L. E. GURLEY



Are you limiting your range and variety of reticle patterns to suit an available reticle-manufacturing process? You needn't at Gurley; here you can obtain the procedure best suited to your particular design and production requirements.

This century-old manufacturer of scientific instruments now offers for the first time on a contract-manufacturing basis its highly-developed photographic, microscopic ruling and etching facilities for producing *glass reticles* for all types of telescopes and optical measuring instruments.

Added to Gurley's extensive reticle-design and manufacturing facilities is an advanced photographic process developed during the war, to meet the low-tolerance specifications for reticles in gunsights and bombsights.

At Gurley you have the flexibility of several manufacturing processes and specially designed equipment to draw on—plus Gurley's long experience in optics, lens grinding and scientific instrument manufacture. Photograph and etch methods, direct ruling on a dividing engine or pantograph, as well as appropriate combinations of several of these methods, broaden the range of reticle pattern designs and assure their economical production in small or large runs.

Consult Gurley on your particular reticle needs —whatever the design or quantity.

W. & L. E. GURLEY, 301 Gurley Bldg., Troy, N.Y.

GURLEY

Optical Reticles, Engineering and Surveying Instruments, Hydraulic Engineering Instruments, Standard Precision Weights and Measures, Paper and Textile Testing Instruments, Aeronautical Navigating Instruments, Meteorological Instruments.

McGRAW-HILL

TECHNICAL WRITING SERVICE

Writing

Whether you need an instruction book or service manual to accompany your equipment written to government specifications . . . or product catalogs . . . or training booklets . . . or industrial literature . . . our writing staff can do the job for you. It will do the research, planning, writing, and organizing to satisfy your requirements.

Illustrating

For government publications or industrial literature, our Art department can meet your specifications, or those of the government agency, for isometrics, exploded views, cutaway views, retouched halftone copy, rendering, lettering, or any other type of art work. It can design to standardized format or present industrial visuals of compelling appeal.

Editing

The editors of our staff are thoroughly familiar with government publication specifications. In addition to being technical editors, they are also experienced in rewriting and organizing rough manuscript, or in revising published material. Many have taught or have been trained in teaching and are, therefore, able to recommend or inject proper pedagogical presentation of material.

Printing

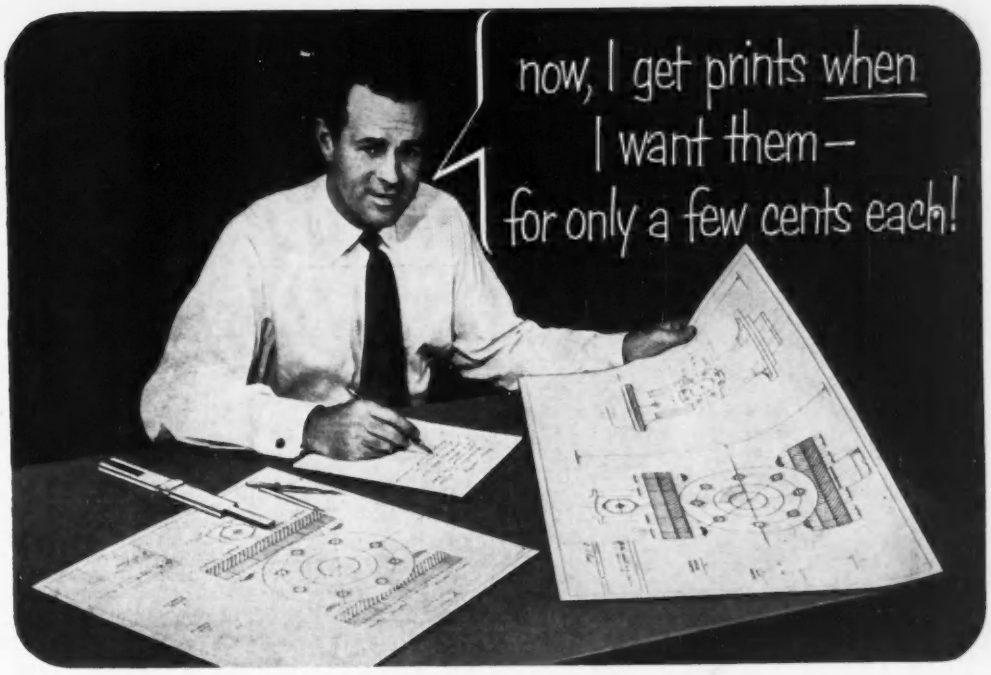
Our printing, binding, and paper resources are among the best in the country. Every type of reproduction is available . . . offset, letterpress, multigraph, or even mimeograph. We can handle a complete printing job or, in the case of offset, furnish repro copy when other facilities must be used.

Save money and time . . . let our staff be your staff for technical publications. Write for our brochure or ask our representative to call.

Technical Writing Service

McGRAW-HILL BOOK CO., INC.

330 West 42 Street
New York 18, N. Y.



NEW! the low-cost* COPYFLEX "20"

With this new, low-cost whiteprinter, the Copyflex "20", you no longer need wait for prints. You get them *when* you want them, *as* you want them—for only 2¢ (average) per. sq. ft.! And that includes *all* costs . . . material, labor, depreciation, etc.

The Model 20 is a completely new, medium volume machine that sells for the lowest price of any machine in its class. It has a full 46" printing width, takes cut or roll stock, and delivers completely developed, ready-to-use prints. It requires no installation, no special training to operate.

Besides making prints of your engineering drawings, it quickly copies production orders, specifications, accounting reports, and other vitally needed paperwork. See how the Model 20, or one of our other models, can help you. Clip the coupon now and you'll be on the road to faster copying – at substantial savings.

Compare these advantages:

- ***LOWEST PRICED** machine of its class available.
- **NO FUMES.** Bruning Copyflex machines use no vapor developer, therefore cannot possibly emit unpleasant fumes.
- **NO INSTALLATION.** No exhausts needed. Just connect to a 115 volt AC electric power circuit.
- **NO TRAINED OPERATOR NEEDED.** Your secretary, the office boy, or anyone else can operate a Copyflex without special training.

BRUNING

Specialists in copying since 1897

CHARLES BRUNING COMPANY, INC.

Dept. V-111 **100 Reade St.** **New York 13, N. Y.**

☐ Send me full details on the Model 20 Copyflex.

☐ I would like to see a Copyflex machine demonstrated.

Name _____ **Title** _____

Company _____

Street _____

City _____ **Zone** _____ **State** _____

Imagine your dog's delight on seeing a solid column of biscuits 160' long and 42" wide! That's the carrying surface of this Cambridge Woven Wire Conveyor Belt in a recirculating oven at Kendall Foods Company, Bell Gardens, California.

Balanced Weave, specified for this installation, is low in cost, eliminates creeping of the belt on the drive pulley, and provides high tensile strength. Open mesh of the belt allows free circulation of heat within the oven . . . crumbs and broken bits of biscuit fall through the belt, cannot foul up automatic packaging equipment at the end of the oven.

Whether you're baking biscuits, processing meat or canning vegetables, there's a Cambridge Woven Wire Conveyor Belt to help mechanize your production. Stainless steel to meet sanitary codes is a standard material of construction for our food plant customers. Call in your Cambridge field engineer today, let him explain the superior construction features of **Cambridge Woven Wire Conveyor Belts . . .**

The Cambridge Wire Cloth Co.
Dept. P • Cambridge 11, Md.

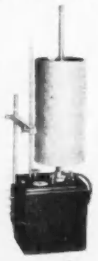
WIRE CLOTH | METAL CONVEYOR BELTS | SPECIAL METAL FABRICATIONS

OFFICES IN PRINCIPAL INDUSTRIAL CITIES
See "Belting - Mechanical" in your Classified Telephone Directory.

WRITE FOR FREE MANUAL illustrating and describing conveyor belt installations for food, metalworking, chemical, ceramic and other processes.

COMPACT! POWERFUL!

BARCOL *synchronous* MOTORS



An open type, powerful, geared BARCOL MOTOR drives the drum in this multi-speed Gorrell & Gorrell Mono-drum. This motor is completely submerged in oil to give years of trouble-free service. The following features are incorporated in the Barber-Colman line of Synchronous Motors:

Type KYAZ BARCOL MOTOR

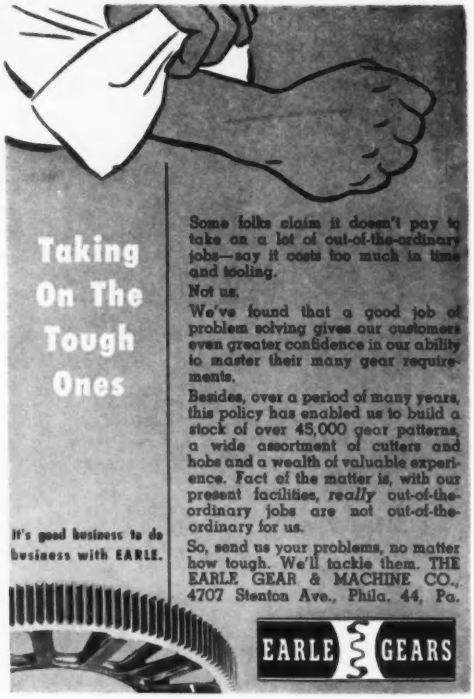
- High torque
- Self starting
- Precision made
- Geared or non-geared
- Open or enclosed
- 6 hr/rev to 3600 rpm
- 25-60 cycles

Our engineering staff is ready to help you with your motor problem. Write today, outlining the application in which you are interested.

WRITE FOR CATALOG...

OTHER BARCOL MOTORS — Unidirectional • Reversible • With and without reduction gearing • Open and enclosed.

BARBER-COLMAN COMPANY
ROCKFORD, ILLINOIS, U. S. A.


Taking On The Tough Ones
Some folks claim it doesn't pay to take on a lot of out-of-the-ordinary jobs—say it costs too much in time and tooling.
Not us.
We've found that a good job of problem solving gives our customers even greater confidence in our ability to master their many gear requirements.
Besides, over a period of many years, this policy has enabled us to build a stock of over 45,000 gear patterns, a wide assortment of cutters and hobs and a wealth of valuable experience. Fact of the matter is, with our present facilities, *really* out-of-the-ordinary jobs are not out-of-the-ordinary for us.
So, send us your problems, no matter how tough. We'll tackle them. THE EARLE GEAR & MACHINE CO., 4707 Stenton Ave., Phila. 44, Pa.
It's good business to do business with EARLE.
EARLE GEARS

Cherry Rivet Company

Lock Bolts

combine the advantages of bolts and rivets... increase strength... save installation time... save 50% in weight assure hi-clinch

Cherry Rivet Company Lock Bolts are high strength, structural fasteners specifically designed to lower overall costs. One man installs them with a special pneumatic tool. Installation time is less than ½ that of conventional bolts and nuts and similar high strength fasteners.

Installed Lock Bolts are 50% lighter in weight than equivalent AN bolts. Their tensile strength is equal to that of the same sized AN bolt, yet their shear strength is considerably greater. On installation, the Lock Bolt clamps the material being fastened tightly together, and securely clinches it under tension. The clamping action is sufficient to pull together a gap between sheets of as much as ¼".

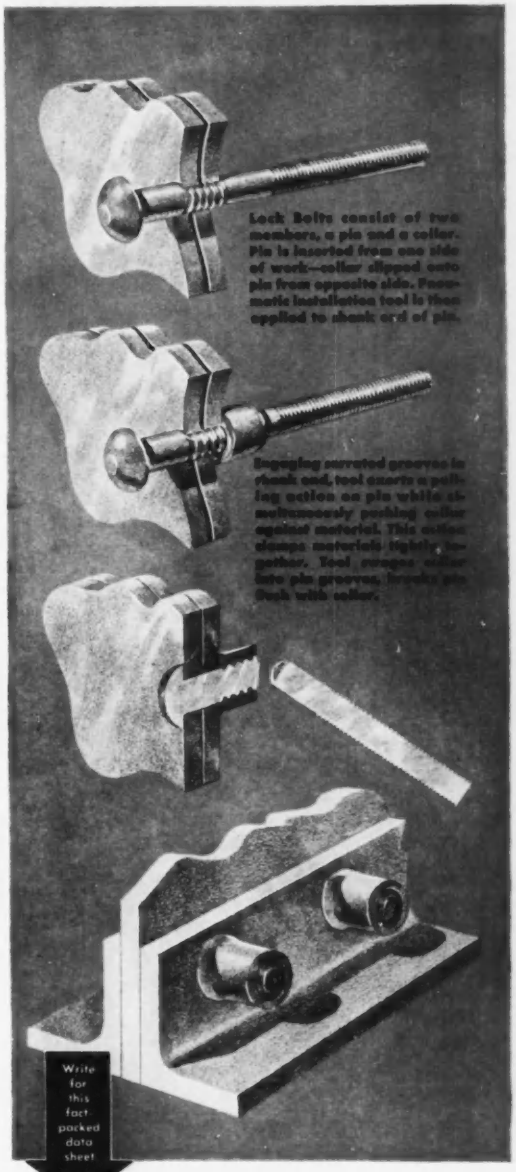
Combining high strength, light weight and rapid installation, Cherry Rivet Company Lock Bolts offer many production advantages you may apply in your business. For complete information write today.

Lock Bolt Availabilities

Materials: 75ST and 24ST Aluminum Alloy, Heat Treated Alloy Steel, Mild Steel
Diameters: 3/16", 1/4", 5/16", 3/8"
Grip Lengths: 1/8" to 1-15/16"
Head Styles: Pan, 100° Flush, Round, Brazier, 90° Flush

Cherry Rivet
COMPANY
A Division of Townsend Company

Here's how Lock Bolts work


Lock Bolts consist of two members, a pin and a collar. Pin is inserted from one side of work—collar slipped onto pin from opposite side. Pneumatic installation tool is then applied to shank end of pin.
Engaging serrated grooves in shank end, tool exerts a pulling action on pin while simultaneously pushing collar against material. This action clamps materials tightly together. Tool swages collar into pin grooves, breaks pin flush with collar.

Write for this fact packed data sheet

CHERRY RIVET COMPANY
Department K-106

231 Winston Street
Los Angeles 13, Calif.

Please send me free of charge your data sheet on Cherry Lock Bolts.

Name_____

Street_____

Company_____

City_____ Zone____ State_____

Don't Forget...

OUR SUB CONTRACT FACILITIES ARE AT YOUR SERVICE

★ ★ ★ ★ ★ ★ ★

During **WORLD WAR II** *We Successfully Performed Numerous Sub-Contracts for a Score of Large Corporations*

DIE STAMPINGS

Some Machined Parts Can Be Produced as Die Stampings with a Saving in Cost and Improvement of Quality and Finish

INDUCTION & TORCH SOLDERING & BRAZING

We Have the Equipment, "Know-How" and Experience

PRECISION PLATING

GOLD • SILVER • COPPER • ZINC
NICKEL • CHROME • CADMIUM
We Have Facilities for Plating on Aluminum

ASSEMBLIES & SUB-ASSEMBLIES

We Have an Excellent Assembly Department with Experience in Handling Intricate Work

Our Facilities **INCLUDE**

DROP HAMMERS • PRESSES • ANNEALING
PLATING • SOLDERING • BRAZING • ENAMELING
POLISHING • BUFFING • ASSEMBLING

Complete Facilities List Gladly Furnished

AMERICAN EMBLEM CO., INC.

HILL STREET, UTICA 1, N.Y.

SALES OFFICES: New York, Chicago, Philadelphia, Cleveland
Representatives in Principal Cities

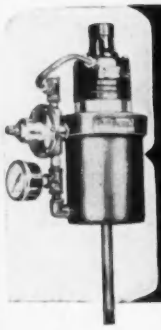
INTRICATE

These new gearing mechanisms are certainly complicated — and precise. But Diefendorf knows how to execute the most difficult gearing job — with closest tolerances. Ask Diefendorf to work with you on new defense gears. All styles. All materials.

DIEFENDORF GEAR CORPORATION

Syracuse, N. Y.

DIEFENDORF GEARS



Up to 5 times faster response with

NEW CONOFLOW PNEUMATIC CYLINDER MOTORS for **THROTTLING CONTROL**

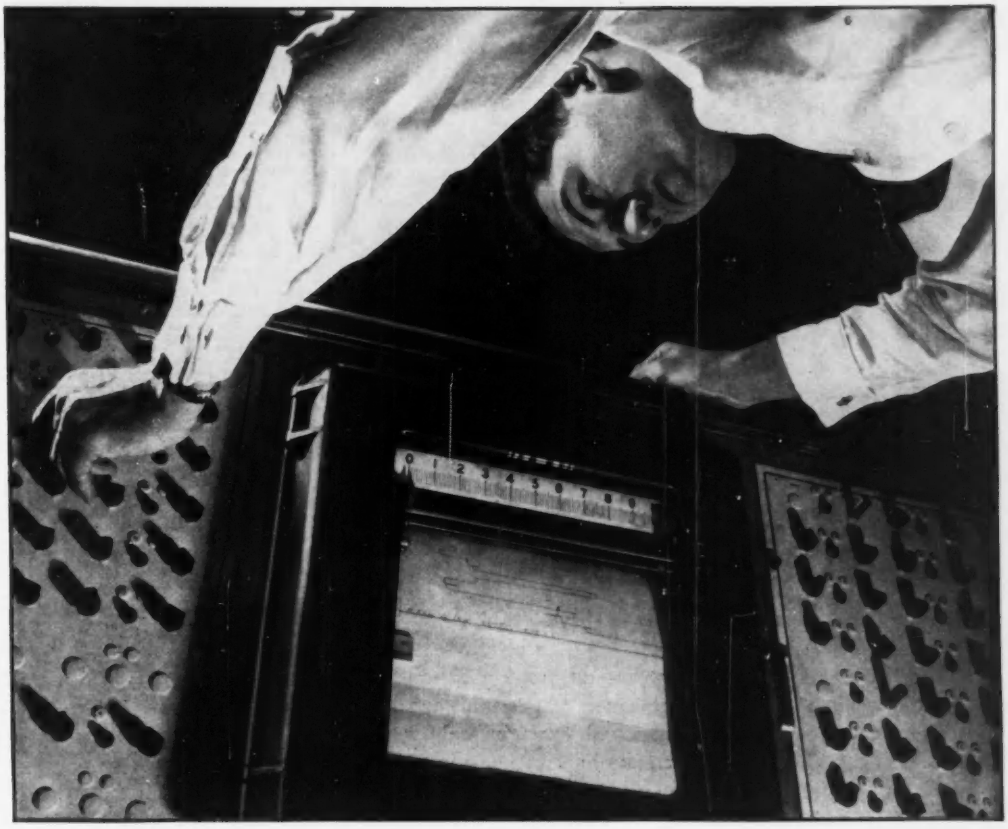
The New B-50 Series of pneumatic cylinders for throttling control service operate on air pressures up to 100 psig and are capable of repositioning accuracies of 1/500 part of total stem travel. Simplified one-piece piston construction features graphite impregnated "O" ring seals and a piston positioner integrally mounted in the head plate. Extra sensitive, speedy and stable—because of minimum friction and precisioned aluminum design.

Many applications include positioning electrical components, variable speed drives, rubber pinch valves, etc. Available in 4", 6" and 8" diameters with 3" and 4" stem travels. Furnished complete with cushion-loading regulator and gauge, fully piped, ready for installation.

Write for bulletin B-50-PE.

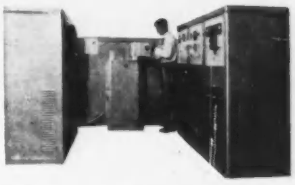
CONOFLOW CORPORATION
2100 Arch St., Phila. 3, Pa.

Cono-Controls



RIGHT from the start . . .

Expert scientific control makes ALUMICAST castings faultless



Illustrations above show the Quantometer which provides our laboratory technicians with a graphically recorded analysis of sixteen different elements—in less than three minutes. This assures the correct casting alloy composition in every "heat". You benefit because of expert scientific control ("E.S.C.").

There's no guesswork done at ALUMICAST. Every step from ingot to the finished casting is subject to scientific tests and controls to assure production of uniformly high quality castings. Right from the start every piece will meet your specifications.

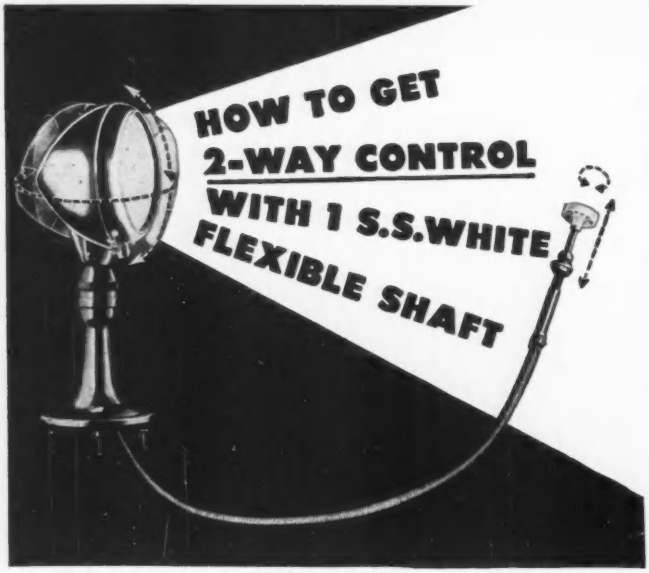
No matter where you are located, you will find ALUMICAST a quick and dependable source for aluminum or magnesium castings. You are cordially invited to consult us relative to your civilian or defense needs.

ALUMICAST CORPORATION, 1517 N. Kilpatrick Avenue, Chicago 51, Illinois.

ALUMICAST

ALUMINUM and MAGNESIUM PERMANENT MOLD and DIE CASTINGS

"E.S.C." EXPERT SCIENTIFIC CONTROL



Courtesy Arnolt Co., Warsaw, Ind.

HERE'S an "on-the-spot" answer to the problem of providing equipment with a combination of push-pull and rotary control. As the illustration shows, with only a single S.S.White flexible shaft, the light can be swung the full 360° arc, and tilted up or down, simply by turning the control knob or by pushing it in or pulling it out.

In addition to the obvious advantages of such an arrangement, the S.S.White flexible shaft is easily installed and allows both the light and its control knob to be mounted in the most desirable location.

If you'd like to get further details on the versatility and usefulness of S.S.White flexible shafts, send for the booklet described below.

S.S.White MAKES IT RIGHT

WRITE FOR NEW BULLETIN 5008

It contains the latest information and data on flexible shafts and their application. Write for a copy today.

THE S.S.White INDUSTRIAL DIVISION
DENTAL MFG. CO.
Dept. D, 10 East 40th St.
NEW YORK 16, N. Y.

Western District Office • Times Building, Long Beach, California

CHECKLIST of outstanding McGRAW-HILL BOOKS

1. VIBRATION and SOUND

By Philip M. Morse, Director, Brookhaven National Laboratory

168 pages, 116 illustrations, $6.00

Here's authoritative information on the theory of vibration and sound—factual material on strings . . . the case of plane waves in tubes . . . and the application of operational calculus and the Laplace transform to the study of acoustical transients. This book explains and analyzes the simple oscillator, the flexible string, the vibration of bars, membranes, and plates, plane waves of sound, the radiation and scattering of sound, standing waves of sound, etc.

2. MECHANICAL VIBRATIONS

By J. P. Den Hartog, Professor of Mechanical Engineering, M. I. T.

3rd edition, 478 pp., 6x9, 282 illus., $6.25

This book deals with vibrational phenomena in a technical manner, yet emphasizes applications of principles and calculations to practical problems of vibration. You receive valuable information on airplane wing flutter, helicopter ground vibration, torsional pendulum dampers, singing ships' propellers, and electronic instruments. The principal applications to steam turbines, automobiles, diesel engines, and electrical machinery are included.

3. MATHEMATICAL THEORY of ROCKET FLIGHT

By J. Barkley Rosser, Professor of Mathematics, Cornell University—Robert R. Newton, Technical Staff Member, Bell Telephone Laboratories, Inc.—and George L. Gross, Research Engineer, Grumman Aircraft Engineering Corporation.

276 pp., 6x9, 41 diagrams, $5.00

Explanations and illustrations in this volume are combined with mathematical analysis to show you factors involved in rocket propulsion. Discoveries in the field are covered by a wealth of explanatory material including concise diagrams, tables, and graphs. Covers such points as how jet forces propel the rocket, how the rocket is rotated for stability, aerodynamic forces on a non-spinning rocket, effect of jet action, dispersion of a rocket, vacuum trajectory, launcher velocity, and tipping-off effects.

4. COMPUTING MECHANISMS and LINKAGES

By Antonin Svoboda, Hubert M. James, Editor, Vol. 27—Massachusetts Institute of Technology Radiation Laboratory Series. ORRD-NDRC.

352 pp., 6x9, 177 illus., $5.00

This guide to recent developments in radar gives you a clear picture of computing mechanisms in general, and includes a detailed study of the design of bar linkages for use in computers. You receive a full account of novel methods for the design of bar linkages as generators of functions of one and two independent variables. Special attention is given to the design of bar linkage multipliers.

10 days free examination

McGRAW-HILL BOOK CO., INC.
330 W. 42nd St., N. Y. C. 18

Send me books corresponding to numbers circled below for 10 days free examination on approval. In 10 days I will pay for books I wish to keep, plus a few cents postage, and will return unwanted books postpaid.*

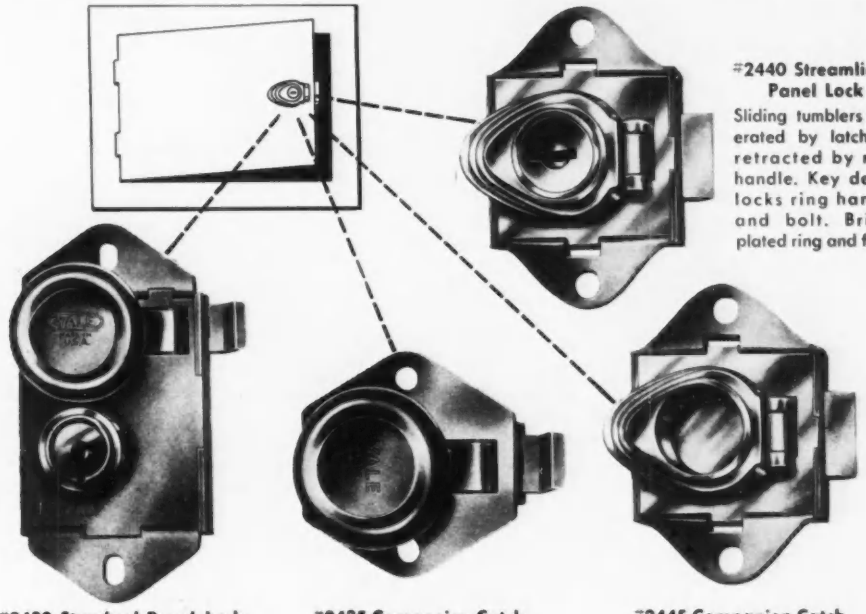
1. 2. 3. 4.

Name .....
Address .....
City ..... Zone .... State .....
Company .....
Position PPE-11-51

* SAVE! We pay postage and packing charges if you send cash with your order. Same return privilege.

BE "SAFETY-CERTAIN" ...SPECIFY YALE

for your electrical panel boards



#2440 Streamlined Panel Lock
Sliding tumblers operated by latchbolt retracted by ring handle. Key deadlocks ring handle and bolt. Bright plated ring and face.

#2430 Standard Panel Lock
Key deadlocks bolt and ring handle which retracts latchbolt to operate. Lever tumbler mechanism. Bright plated ring handle and nose.

#2435 Companion Catch
Ring handle retracts latchbolt to operate. Reversible for either right or left hand opening doors. Bright plated ring handle.

#2445 Companion Catch
Reversible for either right or left hand opening doors. Ring retracts latchbolt to operate. Bright plated ring and face.

Rugged...economical...YALE locks and catches are designed to meet any job requirements

TAKE NO CHANCES! Be certain of quality hardware and maximum security for electrical panel boards by taking your pick of the many YALE locks and catches available.

YALE is *the* economical choice, as well! For, YALE locks and catches are designed in appearance and function to fit your toughest job requirements—saving you the usual expense and trouble of "special order" jobs. What's more, they're easy to install!

So, specify YALE! Get all the facts about this outstanding line of YALE hardware and put yourself days and dollars ahead on every job. There's a YALE lock and catch for every application. For detailed information write The Yale & Towne Manufacturing Co., Dept. S-2211, Stamford, Conn.

YALE & TOWNE

Yale is a registered trade mark

An Arwood casting saves time! money!

ARWOOD'S engineering skill and production efficiency make it possible to produce the cam illustrated by the precision investment casting method.

This is a stainless steel release cam for food machinery. Originally it was to have been machined from a 2" solid cube of steel. But made as an investment casting, all machining has been eliminated except the drilling of one small blind hole and the turning of the shank to a tolerance of ± .0005. Notice the details of the slot and cam groove which are held to tolerances of .004.

While the saving of valuable machining time is important, it is interesting, too, that an actual saving of 58% was made over the cost of making the cam by other methods.

Perhaps you have a production problem that Arwood can help you solve. Our engineers, with years of experience in many industries, often are able to make valuable suggestions that result in important savings in manufacturing.

For more complete information about the accuracy, the lower costs and the versatility of precision casting, write for our booklet, "A Critical Survey of Investment Castings."

ARWOOD

PRECISION CASTING CORP.

68 WASHINGTON STREET • BROOKLYN 1, N. Y.

Plants: Brooklyn, N. Y., Groton, Conn., Tilton, N. H.

POCKET-SIZED POWERHOUSE

ANGLgear

Manufacturers are amazed at the work this unique right-angle bevel gear drive does, the space it saves, the problems it solves. ANGLgear has unlimited applications in the industrial field.

CHECK THESE FEATURES . . .

√	Hardened gears
√	Antifriction bearings
√	Flanged end mountings
√	Three-bolt side mounting
√	Internal pilot on mounting ends
√	Lubricated for life

SOLD THROUGH LEADING DISTRIBUTORS THE COUNTRY OVER

AIRBORNE

ACCESSORIES CORPORATION

1414 Chestnut Avenue, Hillside 5, New Jersey

A.A.C.

DOUBLE the POWER

and you double the use of your FORD Tractor

with a **FUNK CONVERSION KIT**

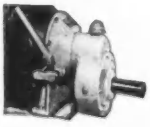
FUNK Products include:

Straight Power Take-Off Clutches

Right Angle Take-Offs

Front End Take-Offs

Gear Reduction Units and Heavy-Duty Clutches



You can do unbelievable jobs with ease when you equip a Ford Tractor with a regular 100 H. P. V-8 or 95 h.p. 6-cylinder Ford engine using our simple change-over kit. Conversion costs about ⅓ as much as most tractors of same power. Reduces initial costs, and enables tractor to handle heavier equipment and accessories. Write for specifications, or assistance on any special power problem.

FUNK AIRCRAFT CO.

3301 Airport Drive **Coffeyville, Kansas**

What's U. S. Rubber doing to bridge the gap between hard and soft rubber?

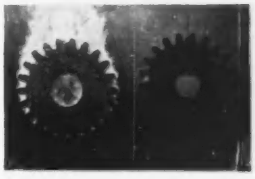
Washing machine parts, formerly made of plastic and metal, now made of new thermosetting plastic, Enrup, which has higher abrasion resistance and is structurally stronger.

The new "U. S." thermosetting plastic, Enrup, can be made flexible and elastic as soft rubber, or rigid as hard rubber. Enrup offers entirely new possibilities to design engineers. The washing machine parts, shown above, are made of Enrup because its abrasion resistance and structural strength are greater than the combination of metal and plastic formerly used.

Enrup can be made into almost any shape or form, simple or complex. It can be punched, sanded, sawed, nailed, bolted, molded and machined. Perhaps Enrup is just what you've been looking for to improve your product or your manufacturing operation.

For more details, write to address below.

Some of the products made of Enrup for leading manufacturers. The smallest items weigh as little as one-third of an ounce. Engineers often find Enrup cuts molding costs, permits operating economies hitherto impossible.



Note how a bath of 20 percent solution of sulphuric acid eats away the steel gear at left, while the Enrup gear is unharmed. Enrup is non-conductive, non-absorbent, easy to clean, is noiseless.

PRODUCT OF

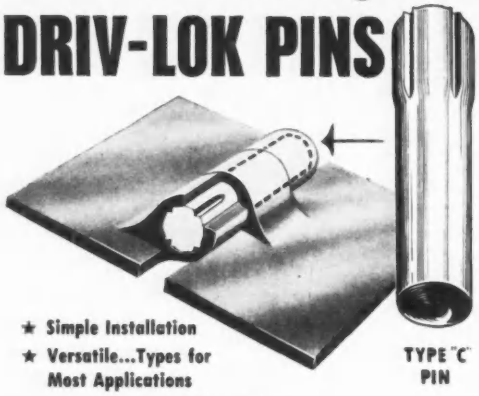
U.S.RUBBER
SERVING THROUGH SCIENCE

UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION • ROCKEFELLER CENTER, NEW YORK 20, N. Y.

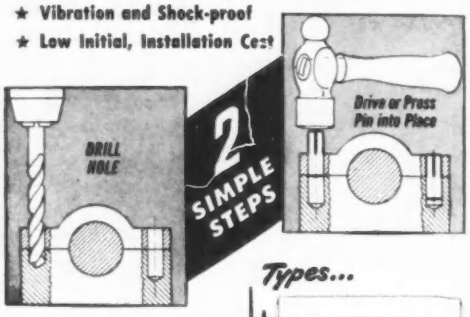
Simple... Dependable...

low-cost fastening with DRIV-LOK PINS



TYPE "C" PIN

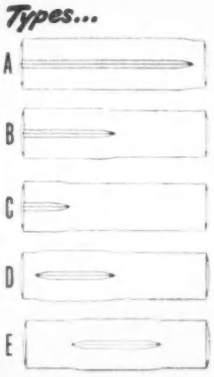
★ Simple Installation
★ Versatile...Types for Most Applications
★ Wide Selection of Materials
★ Vibration and Shock-proof
★ Low Initial, Installation Cost



DRIV-LOK Pins are widely used as hinge and pivot pins because they permit maximum free rotation of one part, while remaining securely locked in the other. Quick, easy installation of DRIV-LOK Pins cuts assembly costs, waste motion is reduced and product improvement results.

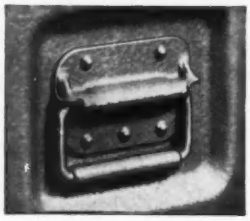
DRIV-LOK Pins are made in many types to handle most applications. Write for catalog and samples, giving nature of your fastening problem.

Types...



DRIV-LOK PIN COMPANY
723 Chauncey St. • Sycamore, Ill.

We've Built a BETTER HANDLE!



FOR MANUFACTURERS OF PORTABLE EQUIPMENT, CARRYING CASES, PARTS BOXES, Etc.!

• non-rattling • rugged construction • rust-proof • meets Air Force and other Government specifications

Here is the handle you have been looking for—one that is ideally suited for anything that must be lifted by a side carrying handle. Bendix-Friez engineers developed this handle to meet Air Force and other Government specifications for many kinds of special equipment. The unique, rugged design of this handle, with its "snap-back" feature, is such that neither shock nor vibration will cause it to rattle. Built of aluminum and stainless steel, it can be riveted or welded to the side surfaces of any kind of container or depressed in the sides. Available in large or small lots, orders will be filled promptly. *Write today for our new lower prices.*

Bendix-Friez

FRIEZ INSTRUMENT DIVISION of Bendix Aviation Corporation
1336 Taylor Avenue
Baltimore 4, Maryland
Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N.Y.

DOES YOUR PROBLEM INVOLVE....

?

. . . if so CONSULT US

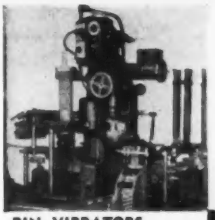
Corrosion Resistance
Strength in Tension and Compression
Hardness & Toughness
Pressure-Tightness
Resistance to Erosion
Resistance to Frictional Wear
Fatigue Resistance

Most certainly there is one of "our own alloys," or one of the many non-ferrous alloys we make that will meet your exact requirements—At any rate, our long and varied experience as Metallurgical Engineers and Founders is at your service for any problem or product you may have.

Please send me a copy of your latest "Reference Book of Bronze Casting Alloys".

AMERICAN MANGANESE BRONZE COMPANY
4705 Rhawn St., Holmesburg, Philadelphia 36, Pa.
PITTSBURGH, PA.
Established 1909

What's Your Problem?

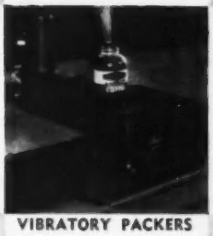


BIN VIBRATORS

VIBRATORY FEEDERS

VIBRATING GRIZZLIES

VIBRATING SCREENS

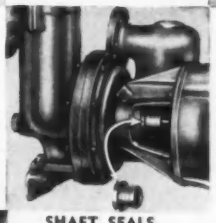


VIBRATORY PACKERS

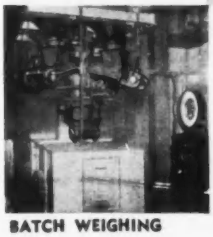
PARTS FEEDERS

HOPPER LEVEL SWITCHES

SELENIUM RECTIFIERS



SHAFT SEALS



BATCH WEIGHING

Clogged bins and hoppers? Slow, unreliable, uncontrolled material feed? Lack of sizing or separation? Does the product require settling or packing down in containers? Are you fumbling around with small parts? Never a happy medium for your hoppers—either empty or overflowing? Difficulties with current conversion? Leaky shafts? Slow, laborious hand batching?

Then ask about—

SYNTRON

ELECTRIC VIBRATORS, promoting free-flowing bins, hoppers and chutes.

VIBRATORY FEEDERS, controlling the flow of materials in packaging machines, etc.

VIBRATORY PACKERS, settling materials in containers and molds.

PARTS FEEDERS, feeding small objects to automatic machinery, machine tools, etc.

VIBRATING GRIZZLIES, for rough scalping.

VIBRATING SCREENS, removing foreign objects, lumps, etc.

SHAFT SEALS to eliminate leakage of gases and liquids.

BATCH WEIGH SYSTEMS, with scale-controlled Feeders and Vibrators.

HOPPER LEVEL SWITCHES, controlling volume content of bins, etc.

SELENIUM RECTIFIERS for efficient conversion of AC to DC.

SYNTRON CO.

240 Lexington, Homer City, Pa.

NOW—

the advantages of

TEFLON*

plus

RAPID, LOW-COST PRODUCTION OF PARTS

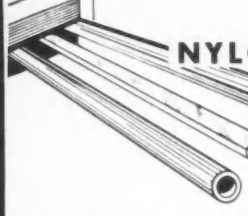
Close tolerance extruded *Teflon* rods in a wide range of sizes recently developed by our engineers, offer fabricating advantages over the short molded lengths previously available. Where *Teflon's* electrical properties or exceptional corrosion or heat resistance is needed, uniform parts can be readily machined from our rod.

Typical *Electrical* Properties of *Teflon*: Electrical properties of *Teflon* are practically unchanged through its useful service range of –100°F. to 480°F. Short-time dielectric strength as high as 1,000 to 2,000 volts per mil, in 2 to 10 mil thicknesses. Long-time dielectric strength reported over 1,000 volts per mil in the absence of corona. Electrical loss factor over frequencies from 60 cps to 30,000 mc is less than 0.0005.

*Teflon is a trademark of the E. I. Dupont Co.

New Folder Contains Complete Information on available sizes of Teflon and Nylon rod, strip and tubing. Write for your copy.

THE POLYMER CORPORATION
Reading, Pennsylvania



NYLON and TEFLON
ROD
STRIP
TUBING

Pioneer Producers of Nylon Rod and Strip

Reprints Available . .

DESIGNING WITH DOLLARS

This special editorial report . . . from the June issue of PRODUCT ENGINEERING . . . contains design check sheets for 35 important classifications of materials, elements, and fabrication methods.

The design data and notations consolidated in these check sheets were compiled with the cooperation of hundreds of experienced product-design engineers throughout industry. You can put this permanently useful information to work for your company by supplying each member of the engineering staff with a copy of "Designing with Dollars." A limited number of reprints are now available at 75 cents each from our READER SERVICE DEPARTMENT.

PRODUCT ENGINEERING
McGRAW-HILL BUILDING,
NEW YORK 18, N. Y.

When it's high pressure... it's AMERICAN!

HYDRAMITE...pressures up to 5000 p.s.i.

High pressure capacity is built into the HYDRAMITE . . . the remarkable new AE radial-piston constant displacement fluid power generator. It has an overall efficiency of 85% without supercharging.

HYDRAMITE is direct-driven through a flexible coupling . . . rotates in either direction. You've the choice of foot, flange or face mounting.

A product of American Engineering Company, makers of the famous Hele-Shaw Pump, HYDRAMITES are already bringing new efficiency and economy on a wide variety of hydraulically-operated equipment. They are available in 3, 5, and 10 g.p.m. oil capacities.

HELE-SHAW . . . variable pressures up to 3000 p.s.i.

The Hele-Shaw is a radial-piston variable displacement fluid power generator. Pressure and reversal of flow are controlled directly at the pump. Discharge can be varied from zero to maximum . . . and can be reversed gradually or instantaneously. Suitable controls available. Capacities range from 3¾ to 50 g.p.m. and upward.

AE

AMERICAN ENGINEERING COMPANY

PHILADELPHIA 25, PENNA.

AE Products include: Hydramite and Hele-Shaw Fluid Power, Taylor and Perfect Spread Stokers, Marine Deck Auxiliaries, Lo-Hed Hoists, Lo-Hed Car Pullers

American Engineering Company
2501 Aramingo Avenue, Philadelphia 25, Pa.

Gentlemen: ☐ Kindly send me complete information about the new HYDRAMITE. ☐ Hele-Shaw.

Name_____ Title_____

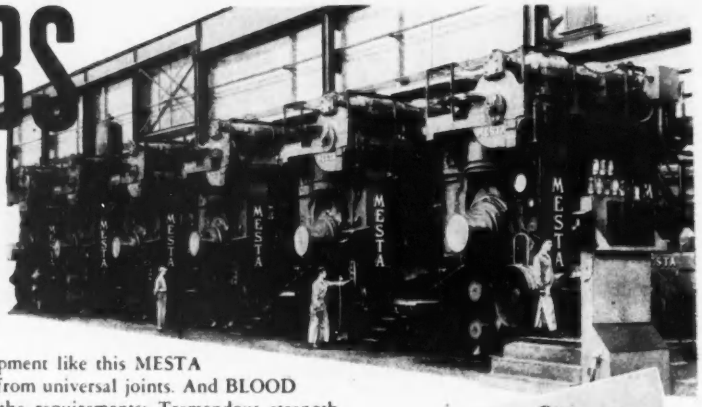
Company_____

Address_____

City_____ Zone_____ State_____

BIG JOBS

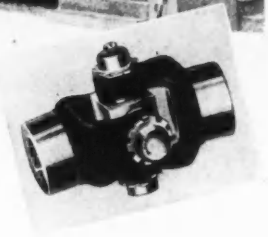
require big Universal Joints ...built by BLOOD BROTHERS



Heavy-duty steel rolling mill equipment like this MESTA 68" Hot Strip Mill demands a lot from universal joints. And BLOOD BROTHERS Universals meet all the requirements: Tremendous strength, long resistance to wear, and toughness to match heavy shocks or starting loads.

That's why — for big jobs or small — industrial machines, commercial vehicles or agricultural implements, engineers rely on BLOOD BROTHERS job-matched universal joints. They've proved their ability to "stand the gaff" through countless hours of rugged duty.

Before you specify, call on BLOOD BROTHERS for engineering consultation and suggestions.



BLOOD BROTHERS machine co. ALLEGAN, MICHIGAN

Division of Standard Steel Spring Co. • Chicago Office: Great Lakes Spring Division, 7035 West 65th Street

CONTROL POWER BETTER

Clutch Engineering Help for Transmission Designers
Whether your transmission problem involves a single or double plate or multiple-disc clutch, a power take-off or a speed reducer, the ROCKFORD engineering staff will contribute over a quarter century of successful clutch application experience toward its practical solution. Thousands of design engineers have utilized this help to fit maximum torque with minimum bulk and weight into compact product designs. Just write or phone for this ROCKFORD field engineering service.
ROCKFORD CLUTCH DIVISION
BORG-WARNER
309 Catherine Street, Rockford, Illinois

ROCKFORD CLUTCHES

CUSTOM BUILT MACHINERY
FOR OVER 75 YEARS

DIXIE-COWDREY
Machine Corporation

[A subsidiary of the Dixie Cup Co.]

Write:
DIXIE-COWDREY
Fitchburg, Mass.
Telephone: Fitchburg 5200

● **DESIGNERS AND BUILDERS OF SPECIAL PURPOSE MACHINERY**

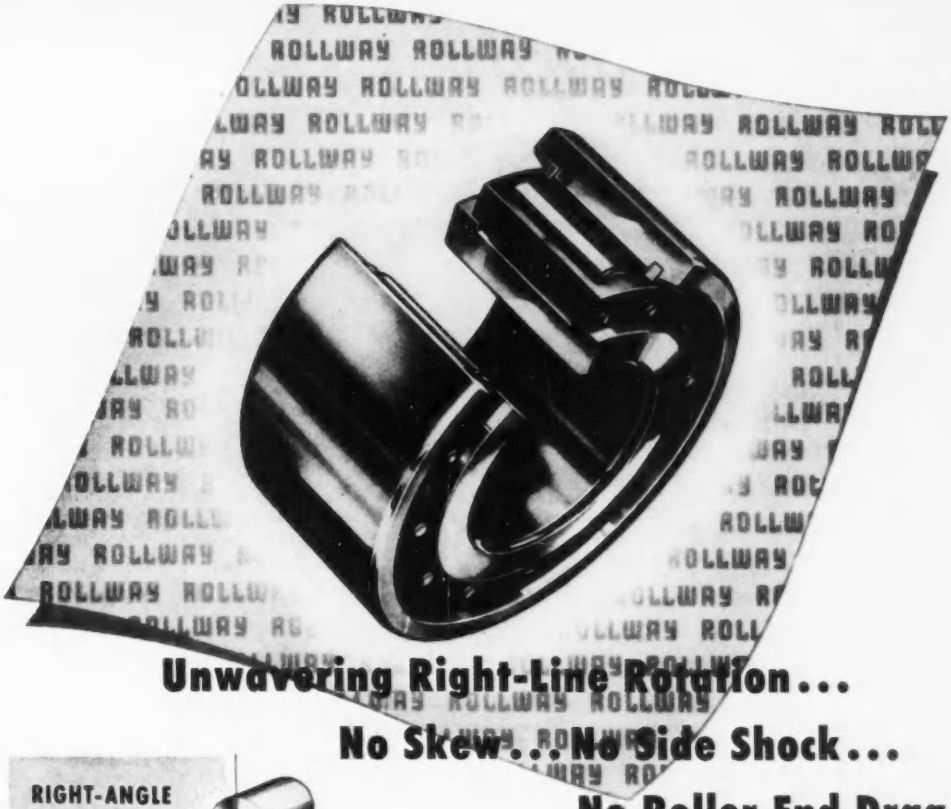
WILLIAMS

DROP-FORGINGS

ANY SHAPE · ANY MATERIAL · COMPLETE FACILITIES

Write for Free Forgings Data Folder . . . Helpful, Informative

J. H. WILLIAMS & CO., "The Drop Forging People" BUFFALO 7, N. Y.

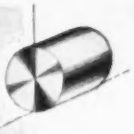


Unwavering Right-Line Rotation...

No Skew...No Side Shock...

No Roller End Drag

RIGHT-ANGLE
ROLLER ENDS, precisely square to avoid end-rub, oscillation and side-shock.



RIGHT-ANGLE
BEARING SURFACES with parallelism that results in unwavering right-line rolling.

RIGHT-ANGLE
SEPARATOR SLOTS accurately machined to prevent roller skew, slide and uneven wear.

Test Rollway Maximum-Type Cylindrical Roller Bearings with your finest gauges. Notice that the bores are precisely cylindrical and that the surfaces of the separators are parallel to each other. The roller ends themselves are truly square on every diameter, and the bearing surfaces match the parallelism of both the separator slots and the roller races.

Line for line and surface for surface, each maximum-type Rollway Bearing is a beautiful piece of related precision and right-angle trueness. Each is precision-engineered for quieter running, lower friction losses and longer life-expectancy under specific conditions of maximum service.

Our engineers will gladly help you select bearings for particular applications. No cost. No obligation. Just write Rollway Bearing Co., Inc., Syracuse 4, N.Y.

SALES OFFICES

SYRACUSE
PHILADELPHIA — BOSTON
PITTSBURGH
CLEVELAND — DETROIT
HOUSTON — LOS ANGELES

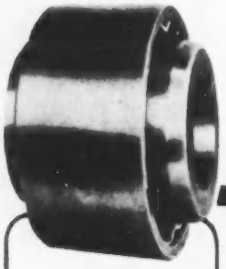
ROLLWAY BEARINGS

Complete Line of Radial and Thrust Cylindrical Roller Bearings

NEW Sier-Bath Flexible GEAR COUPLINGS

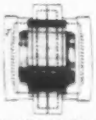
Now Standard Equipment On

KOEHRING 34-E Twinbatch PAVERS



ASSEMBLED
UNCOUPLED in seconds!

ONLY 7 PARTS



3/8 USUAL SIZE
1/2 USUAL WEIGHT
Sier-Bath Gear Coupling compared with two major conventional types of same shaft size, HP rating.

A size 2 Sier-Bath Gear Coupling connects the gear reduction drive with the engine, transmits 130 HP.

SAVE SPACE, WEIGHT, ASSEMBLY TIME—
REDUCE STRAIN ON SHAFTS, BEARINGS

The new Sier-Bath Gear Coupling is cutting costs and improving products for manufacturers in many industries. Revolutionary in its simplicity, the new Coupling eliminates nuts, bolts, grids and discs. The entire load is transmitted from hub to hub by a powerful one-piece sleeve. Precision cut teeth provide plenty of flexibility, minimize backlash. If your products use direct drives, be sure to

WRITE FOR THIS BULLETIN!

gives installation photos, cost-cutting advantages, plan drawings, specs for standard, vertical, mill motor and floating shaft types—sizes from 3/8 to 6, HP 4 to 550. (Special types and sizes on request.)

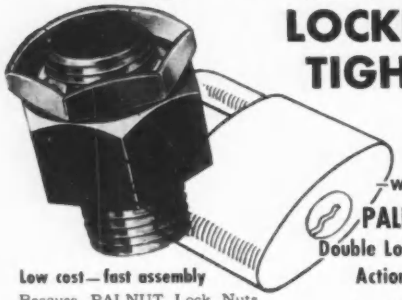
Founded 1905 Member A.G.M.A.

Sier-Bath GEAR and PUMP CO., Inc.

9238 HUDSON BLVD., NORTH BERGEN, N. J.

Also Manufacturers of Precision Gears and Screw and Gearox Rotary Pumps.

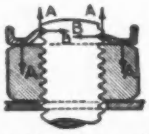
Both Nut and Bolt are LOCKED TIGHT



—with PALNUT Double Locking Action

Low cost—fast assembly

Because PALNUT Lock Nuts apply on top of ordinary nuts, there are no interfering parts within the nut or between the nut and load to prevent or retard the full application of bolt stress for maximum bolt loading efficiency. A properly tightened nut, locked with a PALNUT, provides a completely vibration-proof, rugged assembly which stays trouble-free during the entire life of your products.

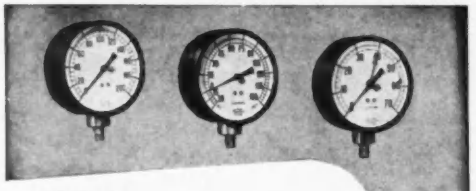


Powerful spring tension (A-A) is exerted upward on the bolt threads and downward on the ordinary nut, while slotted jaws (B-B) close in and grip the bolt like a chuck.

PALNUT Trademark **LOCK NUTS**

Write for samples and data

THE PALNUT COMPANY
65 Cordier St.
Irvington 11, N. J.



1001 GAUGES to choose from

The combinations of styles, types, mountings, ranges and functions of Marsh Gauges are almost endless; but they all have one trait in common: Each is best for the service for which it is recommended. Write today for the new Marsh Catalog covering the broad Marsh line. Let us prove that Marsh is the gauge for your product, whether you need a few or thousands.

Marsh Instrument Co.
Sales affiliate of
Jas. P. Marsh Corp.
Dept. 39, Skokie, Ill.

MARSH

KOLLSMAN INSTRUMENTS

Aircraft Instruments and Controls

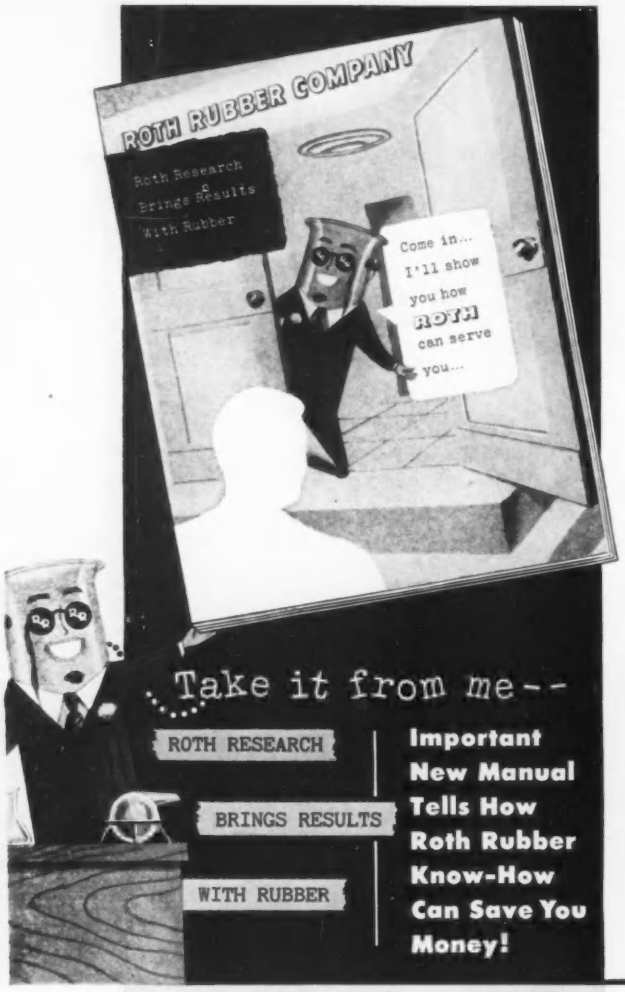
Radio Communications and Navigation Equipment

For precision and dependability look to KOLLSMAN

KOLLSMAN INSTRUMENT CORPORATION

ELMHURST, NEW YORK — GLENDALE, CALIFORNIA

SUBSIDIARY OF *Standard* COIL PRODUCTS CO. INC.


ROTH RUBBER COMPANY
Roth Research
Brings Results
With Rubber
Come in... I'll show you how ROTH can serve you...
Take it from me--
ROTH RESEARCH
BRINGS RESULTS
WITH RUBBER
Important New Manual Tells How Roth Rubber Know-How Can Save You Money!

Get this manual and let us quote on your present rubber requirements—or create a special formula to cut your costs, boost output, or simplify production.

ROTH RUBBER COMPANY

1864 S. 54th Avenue
Chicago 50, Illinois

Custom Manufacturers of Industrial Rubber Products since 1923

WRITE, WIRE, OR MAIL COUPON TODAY!

Please send me the new manual describing your production facilities and products.

Name_____

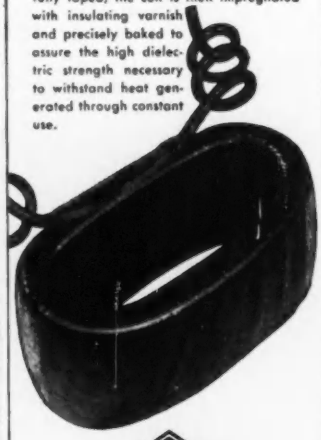
Company position_____

Company_____

Street Address_____

City_____ State_____

The Taft-Peirce SUPERPOWER magnetic chuck is demonstrably the most powerful magnetic chuck made, possessing holding power even greater than is demanded by the latest machine tools. Shown below is a coil which helps give this famous chuck its SUPERPOWER. Accurately form wound from cotton-covered enamel wire and carefully taped, the coil is then impregnated with insulating varnish and precisely baked to assure the high dielectric strength necessary to withstand heat generated through constant use.



Coto SINCE 1917

Builds Them!

When you need electrical coils, why not take advantage of 34 years of experience, engineering competence, and modern production facilities. Coto coils are built for you, to your specifications.

COTO-COIL CO. INC.

COIL SPECIALISTS SINCE 1917

65 PAVILION AVE
PROVIDENCE 5, R.I.

One little spring
or an "ocean" of them.....
Raymond is always ready to
supply your needs !

How can YOU use it?

Penmetal

EXPANDED METAL

as used in this

Open Shelf Display Rack

"How to make a little metal go a long way"

The rugged 1½" mesh is being used for heavy duty jobs. The dainty, almost jewel-like 3/16" mesh is used for ornamental grilles such as for radio and TV. For sizes between there are hundreds of proven uses, with new ones developing every day.

Expanded Metal is used extensively today, and promises to be increasingly in demand in the future. Architects, engineers and designers are finding new applications constantly. Everywhere that strength without bulk is desired, where substantial saving in critical metals is essential, where reduction in weight is important, where the passage of light and air is wanted, where decorative effects are sought, there is a place for PENMETAL Expanded Metal.

Standard or flattened, light or heavy gauge; large or small mesh; carbon or stainless steel, copper, aluminum, Monel, Inconel or other metals; unfinished, polished, painted or enamelled; either exposed or concealed; it has endless possibilities for efficient, economical use.

Our New Expanded Metal Catalog, telling the whole story of this multi-use material, showing many present uses and suggesting others is yours without charge. May we send a copy to you?

82nd PENMETAL YEAR

Penmetal

PENN METAL COMPANY, INC.

General Sales Offices 205 East 42nd Street, New York 17, N. Y.

District Sales Offices

Boston . New York . Philadelphia . Chicago . Detroit . Indianapolis
Seattle . Los Angeles . San Francisco . Dallas . Parkersburg, W. Va.

Factories: Parkersburg, W. Va.

For low-cost performance of

INDUSTRIAL RUBBER PRODUCTS

. . . use these practical application and maintenance aids

Here's a handy reference that gives you a thorough analysis of the engineering, design, application, and maintenance principles you must take into account when working with rubber in industry. Whether you're an engineer—designer—shop superintendent—industrial technician—no matter what your link with the rubber field . . . you'll find this concise treatment of the physical and chemical properties of rubber compounds a handy and practical guide.

ENGINEERING WITH RUBBER

Edited by Walter E. Burton

In collaboration with engineers and research men of the B. F. Goodrich Company

461 pages, 445 illustrations, $6.50

THIS reference book gives you the practical **engineering, application, maintenance and design** principles of molded, extruded and lathe-cut rubber, hose, gaskets, belting, and scores of other rubber parts used by industry. It illustrates uses for American-made rubbers, crude and reclaimed rubbers and rubber-like materials . . . presents a complete picture of the physical and chemical properties of rubber compounds, the typical dimensions and structural details of industrial rubber products.

This guide shows you how to reduce vibrations with rubber mountings —how to determine when extruded rubber parts can be used—how to use packing and sheet rubber, etc. Its tremendous store of useful information is ready to help you find the right answers, the first time, to your specialized design and construction problems.

Stage-by-stage procedures show you how:

- to select and use rubber adhesives
- latex parts can improve product design
- to engineer and install V-belt drives
- to select rubber linings to withstand chemical action
- to design and install conveyor belt systems
- to work and use hard rubber
- to specify correct types of rubber hose for best service
- lathe-cut rubber can reduce costs

SEE IT 10 DAYS' FREE

McGraw-Hill Book Co., Inc., 330 W. 42 St., NYC 18

Send me a copy of Burton's **ENGINEERING WITH RUBBER** for 10 days' examination on approval. In 10 days I will remit $6.50, plus few cents delivery charges, or return book postpaid.*

Name .....

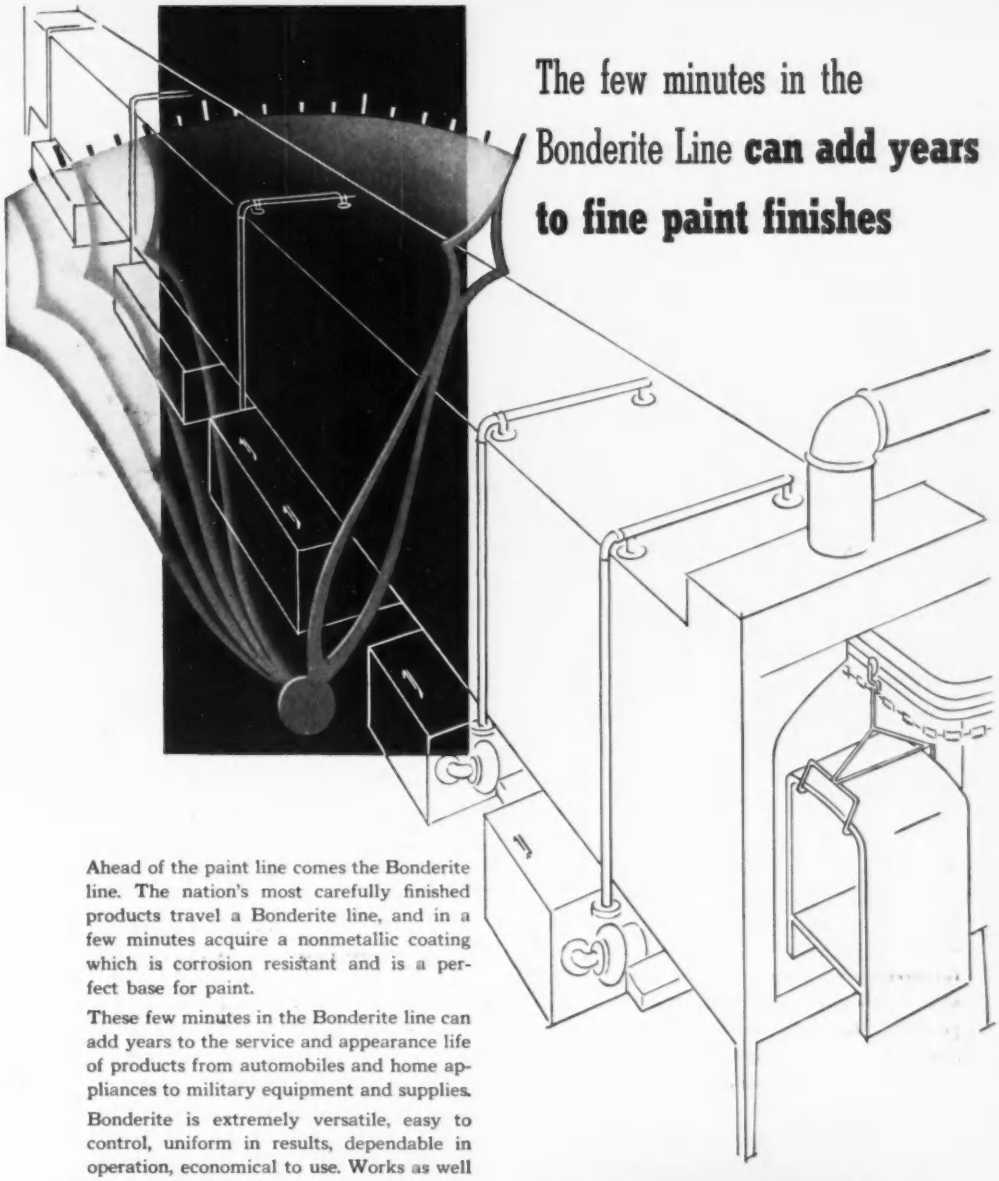
Address .....

City .....Zone.....State.....

Company .....

Position FPE-11-51

*SAVE! We pay mailing costs if you send cash with this coupon. Same return privilege.



The few minutes in the Bonderite Line **can add years to fine paint finishes**

Ahead of the paint line comes the Bonderite line. The nation's most carefully finished products travel a Bonderite line, and in a few minutes acquire a nonmetallic coating which is corrosion resistant and is a perfect base for paint.

These few minutes in the Bonderite line can add years to the service and appearance life of products from automobiles and home appliances to military equipment and supplies.

Bonderite is extremely versatile, easy to control, uniform in results, dependable in operation, economical to use. Works as well in immersion tanks for limited production as on the largest mass production lines.

Get complete information on Bonderite now. Write today!

BONDERITE—corrosion resistant paint base

BONDERITE and BONDERLUBE—aids in cold forming of metals

PARCO COMPOUND—rust resistant

PARCO LUBRITE—wear resistant for friction surfaces

Parker

Parker Rust Proof Company
2179 E. MILWAUKEE AVE.
DETROIT 11, MICHIGAN

**Bonderite, Bonderlube, Parco, Parco Lubrite—Reg. U.S. Pat. Off.*

Whatever Your Carburetion Problem— Look to

Zenith

For the Answer!

Yes, Zenith is your best bet no matter what your carburetion problem! More than thirty-five years' experience in dealing with all types of gasoline engines has resulted in a range of carburetor types and sizes nowhere else available. Let Zenith apply this knowledge and experience to help you find the right size and type carburetor for your needs. Consult us before you finalize a design, and the chances are good that you can use a unit we are already making. Thus you may avoid the necessity of using an individually built carburetor at a premium cost. Your inquiry will receive immediate attention.

ZENITH CARBURETOR DIVISION OF
696 Hart Avenue
Detroit 14, Michigan
Bendix AVIATION CORPORATION

MANUFACTURERS OF FINE CARBURETORS AND FUEL FILTERS

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N.Y.

Complete, comprehensive guide to piping design and application

—The data and methods you need for solving every piping problem

HERE is an indispensable tool for the engineer, contractor, and designer, the famous PIPING HANDBOOK. This vast compilation of data and methods for most effective use of piping puts at your fingertips all the principles that influence the design, construction and use of piping systems. *Any* fact, on any phase of piping practice, is here in clear, dependable, accessible form.

PIPING HANDBOOK

Fourth Edition

By SABIN CROCKER

Senior Engineer, Engineering Division, The Detroit Edison Company

1376 pages, 4½ x 7½, 334 illustrations, 329 tables, $8.50

Solve your piping problems with the help of this practical handbook packed with piping fundamentals, materials and techniques . . . and authoritative information you need on codes, dimensional standards, materials specifications, construction details, cost estimating, etc. It shows you the best types of apparatus for each job . . . brings you sources of methods for using equipment for best results, helpful analyses of the details of each job, easy-to-follow explanations of every phase of piping from start to finish.

Covers these piping fields

- Steam Power-plant Piping
- Building heating
- Plumbing
- Underground Steam Piping
- Water-supply Piping
- Fire-protection Piping
- Oil and Refinery Piping
- Gas Manufacture and Distribution
- Refrigeration
- Hydraulic Power Transmission

SEE IT 10 DAYS FREE

Look over this handbook at your leisure; note its wealth of helpful diagrams, curves, flow sheets, tables and photographs . . . its practical and accurate solutions of everyday problems. Return of the coupon below brings you a copy for FREE EXAMINATION. Send for it today.

McGRAW-HILL ON-APPROVAL COUPON

McGRAW-HILL BOOK CO., 330 W. 42 Street, New York, 18

Send me Crocker's PIPING HANDBOOK for 10 days' examination on approval. In 10 days I will send $8.50, plus few cents for delivery, or return book. We pay for delivery if you remit with this coupon; same return privilege.

Name .....

Address .....

City ..... Zone..... State.....

Company .....

Position PPE-11-51

Books sent on approval in U. S. and Canada only.

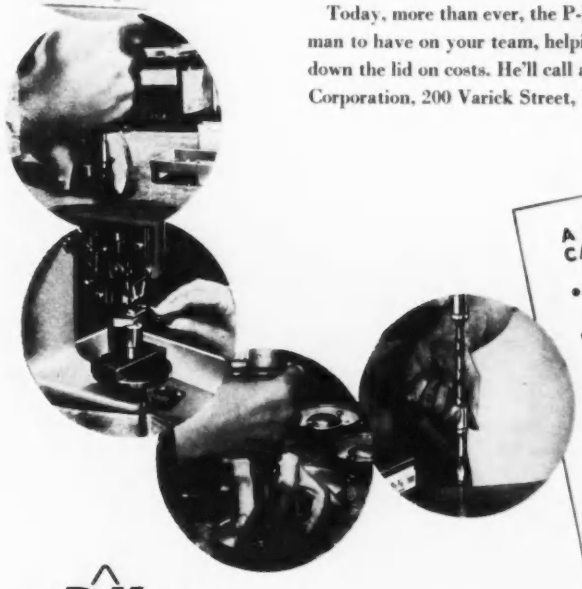
A P-K ASSEMBLY ENGINEER WILL HELP YOU

Give Highly Paid Hands a Head Start . . .

With the experience of more than a million applications to draw on, a P-K Assembly Engineer can quickly spot the fastenings that can be made simpler, faster, and stronger. He'll help you find out where needless operations are slowing up your highly paid assembly hands.

A fastening expert, his advice is unbiased. Since Parker-Kalon makes a *complete* line of Self-tapping Screws, his purpose is to determine the *right* screw for the job, *not* to fit the job to a certain type screw. Listed here are just a few of the many ways P-K Assembly Engineers are helping manufacturers speed fastening operations on all types of products.

Today, more than ever, the P-K Assembly Engineer is a good man to have on your team, helping you boost production and hold down the lid on costs. He'll call at your request. Parker-Kalon Corporation, 200 Varick Street, New York 14, N. Y.



A P-K ASSEMBLY ENGINEER CAN SHOW YOU . . .

- How assemblies can be made with fewer fastenings.
- Where standard screws can be used instead of specials.
- How to use available types instead of those in short supply.
- Where to use power drivers for added speed.
- Where various head styles can be used to advantage.
- How to save time in selecting and ordering screws.
- How to save time in training new assembly help.

WHAT IS YOUR FASTENING PROBLEM?

IF IT'S P-K IT'S O.K.

The Original

PARKER-KALON® SELF-TAPPING SCREWS

A TYPE AND SIZE FOR EVERY METAL AND PLASTIC ASSEMBLY

This picture* does not equal 10,000 words

This is a fine photograph—but men and machines are only part of the story at IGW. It takes esprit de corps (a much overworked term that fits here)—it takes pride of workmanship to produce fine precision gears and parts.

* This Horizontal Jig Borer is typical of the high precision tools designed and built by Indiana Gear for their own use.

Indiana GEARS

GEARS • CAMS • INTRICATE AND PRECISE MACHINE PARTS

INDIANA GEAR WORKS • INDIANAPOLIS 7, IND.

Plastic EXTRUSIONS

FLEXIBLE and RIGID

any special shapes:

RODS
TUBES
STRIPS
BELTING
EDGING
BINDING

- POLYSTYRENE
- CELLULOSE ACETATE
- POLYETHYLENE
- VINYLS
- ETHYL CELLULOSE
- BUTYRATE
- ACRYLIC

GERING PRODUCTS INC.
KENILWORTH, N. J.

Write Dept. PE

VALUE BONUS at no extra cost with the

MARK-TIME two-speed BELL TIMER

first where quality counts

This exclusive, patented Mark-Time development permits use of the same timing unit for accurate, dependable timing of a 6 minute or 60 minute cycle.

Just shift the lever to change setting. The same dial is used for both cycles, thus providing fractional minute calibration for 6 minute operation.

2 hour — 12 minute timings also available.

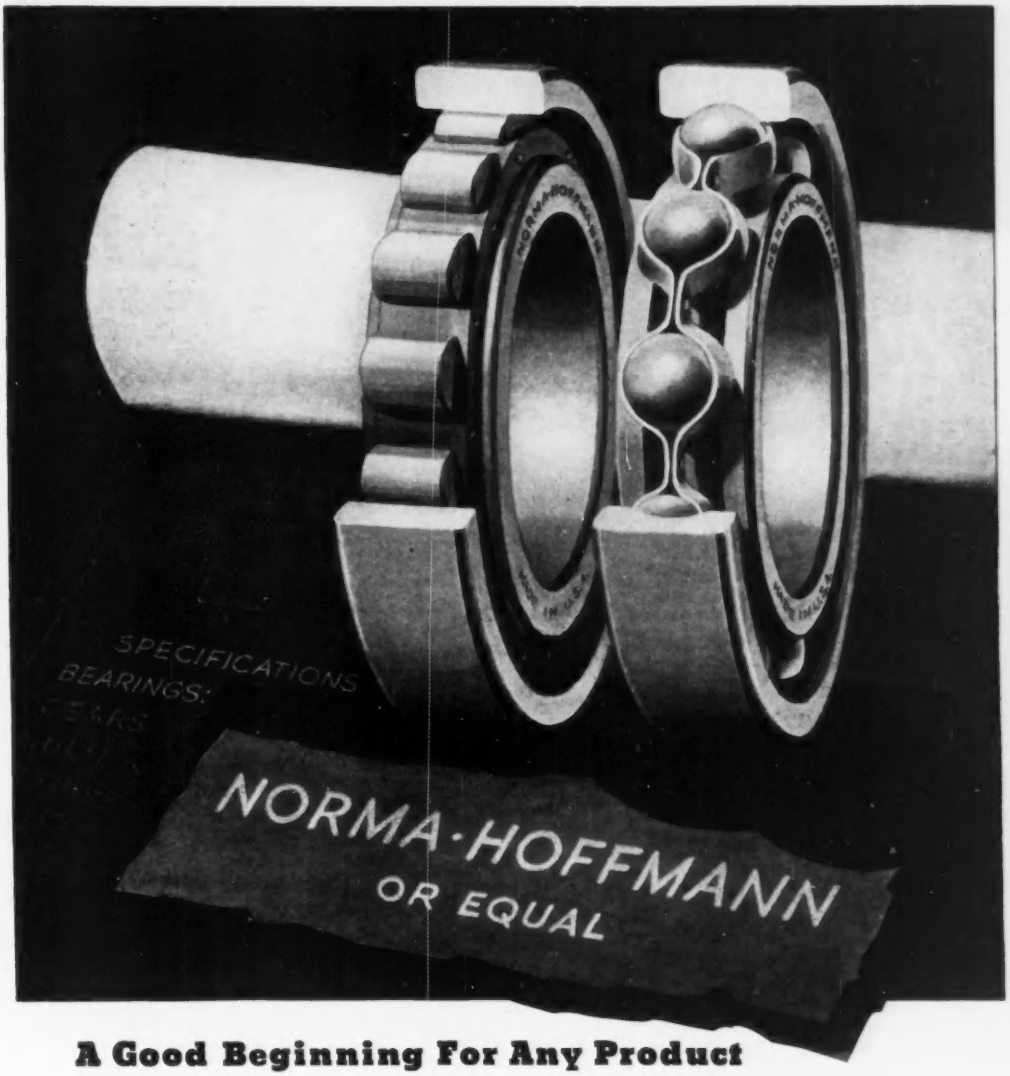
Available in a wide variety of dials and knobs.

Write for further details and prices.

MARK-TIME 2100-SERIES TWO-SPEED BELL TIMER
Center Stud mounting only. May be supplied in panelable form.

In Canada send inquiries to: Ontario Hughes Owens Co. Ottawa, Ontario

M. H. RHODES, INC.
HARTFORD, CONNECTICUT

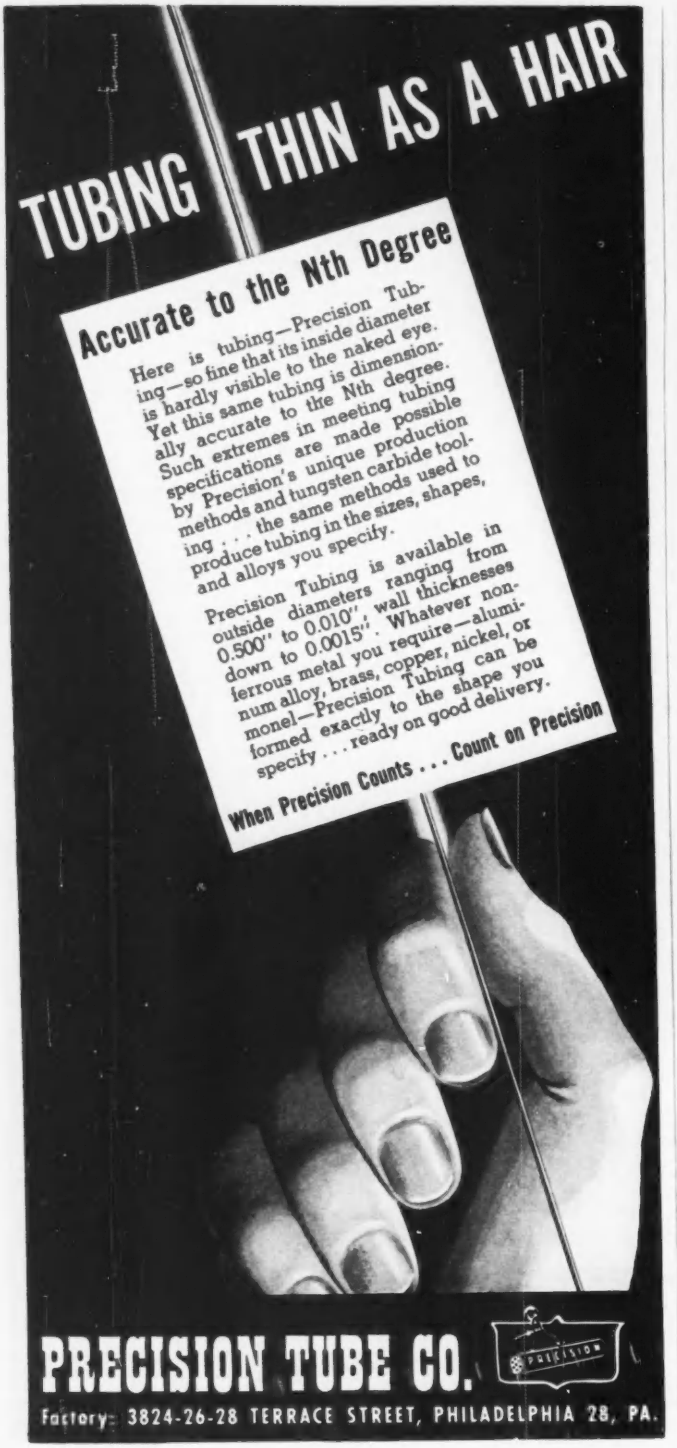


A Good Beginning For Any Product

Here's why "Norma-Hoffmann or equal" is found on thousands of blueprints embracing all types of equipment. It results from designers' preference for bearings that have earned a reputation over the past 30 years for *precision* and *quality*.

And with good reason! These bearings provide ruggedness, dependability, long life and low upkeep. They assure minimum cost per bearing-year of service. Their accuracy and built-in high antifriction characteristics improve product performance. While the wide range of choice . . . 108 distinct series, over 3,000 sizes . . . makes selection easy.

NORMA-HOFFMANN
Precision
BEARINGS
BALL • ROLLER • THRUST


TUBING THIN AS A HAIR
Accurate to the Nth Degree
Here is tubing—Precision Tubing—so fine that its inside diameter is hardly visible to the naked eye. Yet this same tubing is dimensionally accurate to the Nth degree. Such extremes in meeting tubing specifications are made possible by Precision's unique production methods and tungsten carbide tooling . . . the same methods used to produce tubing in the sizes, shapes, and alloys you specify.
Precision Tubing is available in outside diameters ranging from 0.500" to 0.010", wall thicknesses down to 0.0015". Whatever nonferrous metal you require—aluminum alloy, brass, copper, nickel, or monel—Precision Tubing can be formed exactly to the shape you specify . . . ready on good delivery.
When Precision Counts . . . Count on Precision
PRECISION TUBE CO.
Factory: 3824-26-28 TERRACE STREET, PHILADELPHIA 28, PA.

DID YOU FORGET

TO TELL US THAT YOU'RE **MOVING** ?

Planning to move? If you are, then won't you please let us know as far in advance as possible? It takes time to make address corrections on your PRODUCT ENGINEERING subscription stencil. By notifying us about your change in address, you make sure PRODUCT ENGINEERING reaches you. There's a handy coupon below to report the change to us. Do it now so you continue receiving your PRODUCT ENGINEERING without a single hitch in service. Thanks for cooperating!

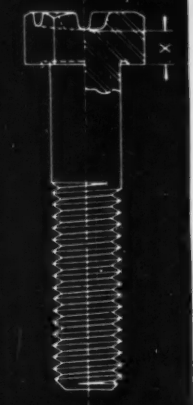
PRODUCT ENGINEERING
Circulation Department
330 West 42nd Street, New York 18, N. Y.
CHANGE OF ADDRESS NOTICE

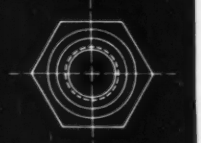
On or about ..... my new address will be:
Street .....
City ..... Postal Zone # ..... State .....
Signed .....
My old address is:
Street .....
City ..... Postal Zone # ..... State .....

Here's how Slotted-Type Head locks

Flexible diaphragm formed between slotted segments in upper face of bolt head and circular recess adjacent to shank in lower face (section X) acts as controlled spring element when head is properly wrenched against a rigid seat. Diaphragm is reinforced by the continuous-grained segments cold-formed between upset slots in upper face.

You're ahead 3-WAYS on *VIBRATION* fastening





with new-type "National" PLACE BOLTS

They're more economical—self-locking—stronger!

MORE ECONOMICAL—Now, for the first time, new Slotted-Type Place Bolts can be made of carbon as well as alloy steels—making possible savings in costs on all applications wherever a locking bolt is needed.

SELF-LOCKING—Place Bolt's spring-action head, tightened against a rigid seat, locks the bolt against all involuntary loosening influences including vibration, and insures against impact of shock failure.

STRONGER—One-piece, all-metal, new Slotted-Type Place Bolts now have reinforced continuous-grained heads that increase their yield and fatigue strength.

In any typical application such as connecting rod bolts, main bearing cap screws, flywheel bolts, and piston pin lock screws, the new "National" Place Bolts can help you solve those critical problems of fatigue and involuntary loosening in automotive, aircraft, farm equipment and other assemblies.

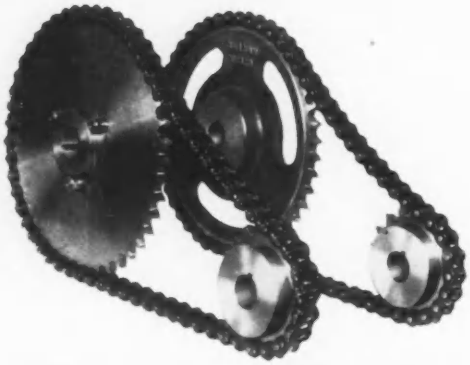
"National" Slotted-Type Place Bolts may be used with nuts, or in tapped holes. They can be made in a wide range of sizes and can also be modified for special applications.

We'll gladly send you more details and prices. Write:

U. S. Patent No. 2543705

THE NATIONAL SCREW & MFG. CO.
2440 East 75th St. · Cleveland 4, Ohio
Pacific Coast: National Screw & Mfg. Co. of Cal.
3423 South Garfield Ave., Los Angeles 22, Cal.

National STUDS AND THREADED PRODUCTS



CULLMAN

Sprockets and Roller Chain

STOCK OR SPECIALS

Utilize Cullman Sprockets and Roller Chains supplied promptly from Cullman's adequate stocks. Cullman Wheel Co. has been supplying high efficiency drives of low first cost and long service life throughout its 56 years of specialization in designing and manufacturing dependable transmission units and components. These factors are the common objective of machine designers and purchasers. Orders for specials are delivered quickly.

Send us your prints and we will quote promptly.

• • •

Many Cullman Distributors ready to serve you.

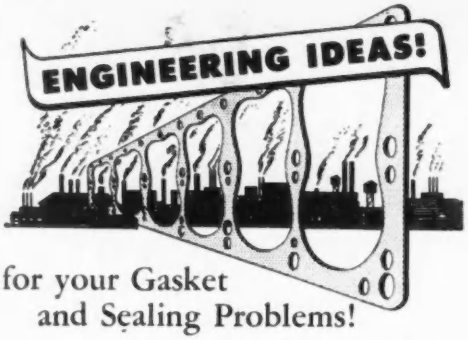
CULLMAN WHEEL COMPANY

1336 West Altgeld St. • Chicago 14, Illinois

CULLMAN

power transmission

SPROCKETS and ROLLER CHAIN



for your Gasket and Sealing Problems!

Looking for new ideas on gasketing or sealing? Let Fel-Pro Engineers help you solve these problems. For over 30 years Fel-Pro has designed and developed sealing materials, gaskets, etc. for industry. This experience can be put to work for you. Send us details and specifications on any of your specific requirements for our cost-cutting, product-improving ideas and recommendations. Write: FELT PRODUCTS MFG. CO., 1534 Carroll Avenue, Chicago 7, Ill.

5620NED

FEL-PRO Utilize Newest Materials ENGINEERED Specifically designed for your product **gaskets**

First In

STAMPINGS IN SMALL LOTS

(Short Runs)

PRECISION DIE MADE — LOWEST POSSIBLE COST

DAYTON ROGERS MFG. CO.

Minneapolis 7, Minnesota

FOUR TYPES OF···

WOVEN BRAKE LINING

COVERING ALL INDUSTRIAL REQUIREMENTS FOR INTERNAL AND EXTERNAL BRAKES

sizes 1 1/2 x 5/32" through 4 x 3/8"

LARGE CAPACITY (10,000 ft. per Day)

LONG EXPERIENCE (since 1927)

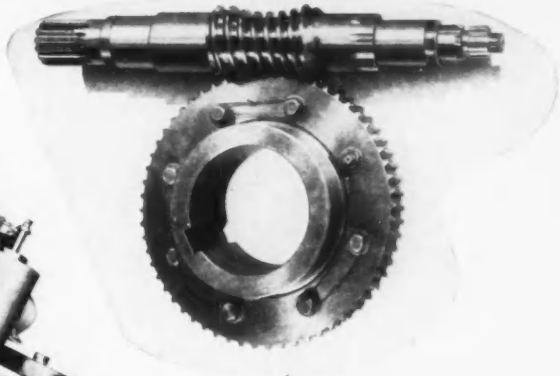
SPECIALISTS IN SHORT RUN ORDERS

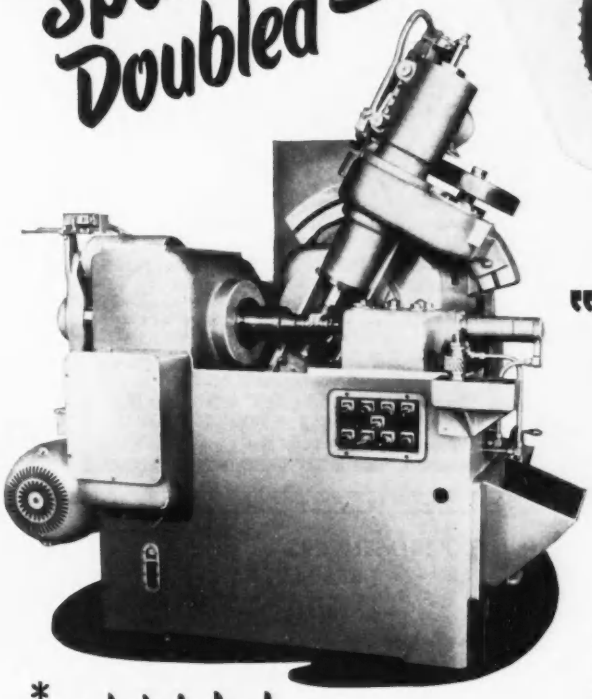
WE INVITE YOUR INQUIRIES

SOUTHERN FRICTION MATERIALS CO.

CHARLOTTE, N.C., U.S.A.

Machine Speed Doubled*—





with "hydraulically" smooth CONE-DRIVE gears

ON the gear hobber illustrated here, high speed steel hobs are now run at CARBIDE SPEEDS—without sacrifice in hob life.

*and tripled

In addition to taking out vibrations, Cone-Drive Gears in this machine also made possible a large reduction in number of gears required in the drive.

Impossible? Not when 'hydraulically' smooth DOUBLE-enveloping Cone-Drive gears are used. The main drive and index drive in this machine use Cone-Drive gears and are so smooth that the usual high-frequency vibrations caused by gearing are eliminated, to all practical purposes.

This vibration-free drive made it possible to run high speed steel hobs efficiently at several hundred feet per minute cutting speed instead of the usual 80 or 90.

That same 'hydraulic' smoothness can do wonders for your machines, too. You can obtain it either through designing standard double-enveloping Cone-Drive gears into your machines or by using complete Cone-Drive reducers instead of built-in gearing.

We will be glad to study your designs for the simplest way to apply the advantages of DOUBLE-enveloping Cone-Drive gears to your equipment.

CONE-DRIVE GEARS
Division Michigan Tool Company
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
7171 E. McNichols Road • Detroit 12, Michigan

"MAYBE I BETTER GIVE IT A TAP WITH THIS."

YOU CAN ALWAYS BE SURE
OF ACCURACY WHEN YOU USE

Bond STOCK GEARS AND PINIONS

There's no risk of getting a gear that won't quite mesh or is too small in the bore—not when you use Bond Stock Gears. You order replacements by using a simple symbol—there is no long list of dimensions which might be mis-read by a machinist making a gear to order. When you order Bond Stock Gears, we simply take the exact item you specify out of stock and deliver it to you without delay.

You can avoid lost production time and wasted man-hours by standardizing on Bond Stock Gears and Pinions. The full line is listed in Bond Catalog No. 65 —write for your copy today.

Carried in stock by
DISTRIBUTORS IN PRINCIPAL CITIES
(Write for name of nearest distributor)

CHARLES BOND COMPANY
617-23 Arch Street, Philadelphia 6, Pa.

Bond
STOCK GEARS
SPEED REDUCERS

FOR YOUR PANEL DIALCO
A NOVEL and UNIQUE CIRCUIT INDICATOR

DESIGNED FOR
NE-51 NEON LAMP
For 110 or 220
volt circuits
The required resistor
is an integral part
of this assembly
—"built-in."
RUGGED
DEPENDABLE
LOW IN COST

PATENTED: No. 2,421,321; Cat. No. 521308-997

WILL *YOU* TRY A SAMPLE?

Write on your company letterhead. We will act at once.
No charge, of course.

SEND FOR THE 192 PAGE HANDBOOK OF PILOT LIGHTS

Among our thousands of Pilot Light Assemblies there is one which will fit your special conditions. Many are especially made and approved for military use. We pride ourselves on prompt deliveries—any quantity.

ASK FOR OUR APPLICATION ENGINEERING SERVICE

Foremost Manufacturer of Pilot Lights
The DIAL LIGHT COMPANY of AMERICA
900 BROADWAY, NEW YORK 3, N. Y. SPRING 7-1300

**EXPERIMENTERS—
RESEARCHERS—
INVENTORS!!!**

Many times you would have liked to know what has been taking place but there was no easy way of doing it. With Alfax electrosensitive paper you simply have to pass a low voltage current through it to produce permanent marks—*RECORD ALL KINDS OF PHENOMENA* with no difficulty.

Investigate by sending for free descriptive literature or send $1.00 for a sample roll of Alfax with directions for use.

ALFAX PAPER & ENGINEERING COMPANY
P. O. BOX 125 WESTBORO, MASS.

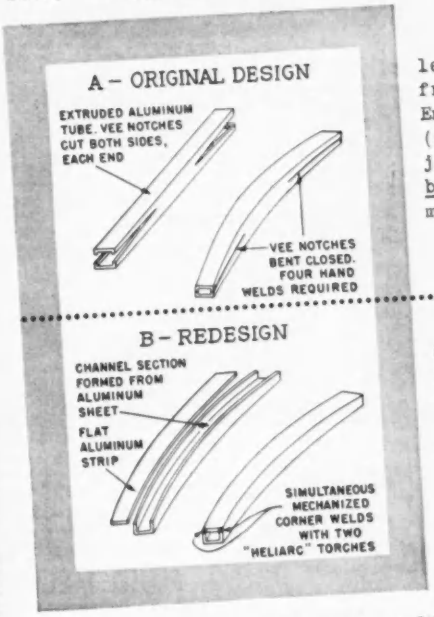
Facts about
PRODUCT ENGINEERING

Product Engineering is the only paid-circulation magazine serving design engineers.

Ideas on Welded Design—For the Engineer's Notebook

CONCENTRATE ON CORNERS

Type and location of joints directly influence both welding method and difficulty of assembly. Edge welds and corner welds are generally easiest, quickest, and least costly to make, regardless of fusion welding method. By recognizing this simple fact, many production headaches can be avoided. For example:


A – ORIGINAL DESIGN
EXTRUDED ALUMINUM TUBE. VEE NOTCHES CUT BOTH SIDES, EACH END
VEE NOTCHES BENT CLOSED. FOUR HAND WELDS REQUIRED
B – REDESIGN
CHANNEL SECTION FORMED FROM ALUMINUM SHEET
FLAT ALUMINUM STRIP
SIMULTANEOUS MECHANIZED CORNER WELDS WITH TWO "HELIARC" TORCHES

One manufacturer used to make legs for aluminum office chairs from sections of extruded tube. Ends were notched on both sides (sketch A), bent closed, and joined by means of four manual butt welds. Production by this method was slow, costs high.

A simple redesign of the part made it possible to speed up the welding, reduce finishing, and cut material costs substantially. Sketch B shows how sheet is now used instead of more expensive extrusions. Both corners of the new assembly are joined in one mechanized welding operation with two "HELIARC" Torches.

For further information about "HELIARC" welding and other cost reducing LINDE methods, phone or write LINDE AIR PRODUCTS COMPANY, a Division of Union Carbide and Carbon Corporation, 30 East 42nd Street, New York 17, N.Y. Offices in Other Principal Cities. In Canada: Dominion Oxygen Company, Limited, Toronto.

The term "Heliarc" is a registered trade-mark of Union Carbide and Carbon Corporation.

Mail this coupon for

MORE PROFITABLE IDEAS

LINDE AIR PRODUCTS COMPANY
30 East 42nd Street, New York 17, N.Y.

Please send me my free copy of 20-page booklet, F-7811, entitled "Improved Design for Welding."

Name.....

Company.....

Street Address.....

City.....Zone....State.....

Check THESE 7 ADVANTAGES

OF SANBORN DIRECT WRITING RECORDING SYSTEMS

1 COMPLETE SYSTEM or SEPARATE COMPONENTS
Sanborn equipment is available as complete 1-, 2-, or 4-channel systems *ready for use*, or as separate instruments (Amplifiers, Preamplifiers, and Recorders), to be combined or integrated by the user with other equipment.

2 NO INK
Permanent records are produced with heated stylus on heat responsive, continuous plastic coated chart paper. Elimination of ink permits, among many advantages, use of the recorder in any position, at any angle, and at high altitudes.

3 RECTILINEAR RECORDS
Records are in true rectangular coordinates (with *negligible* tangent error), permitting more accurate correlation when two or more channels are used simultaneously.

4 HIGH TORQUE MOVEMENT
The writing arm is driven by a D'Arsonval moving coil galvanometer with an extremely high torque movement (200,000 dyne cms per cm deflection). Sensitivity 10 m.a./cm deflection.

5 WIDE CHOICE OF PAPER SPEEDS AND RECORDING CHANNELS
Basic choice of 1-, 2-, or 4-channel models. Single channel standard speed 25 mm/sec., slower speeds available. Two channels, 10 speeds — 5 and 0.5, 10 and 1, 25 and 2.5, 50 and 5, 100 and 10 mm/sec. Four channel, eight speeds — 50, 25, 10, 5, 2.5, 1.0, 0.5, and 0.25 mm/sec.

6 CODE & TIME MARKINGS
All models provide a means of inserting timing pips in the record once each second independently of the paper drive, and code markings at will.

7 INTERCHANGEABILITY
Ready interchangeability of Amplifiers and Preamplifiers in all Sanborn systems permits a wide variety of recording combinations.

WRITE FOR COMPLETE CATALOG

If your problem involves recording any phenomena (individually, or simultaneous recording of up to four) that can be expressed electrically, you will find Sanborn equipment ideally suited to your requirements.

1-CHANNEL

2-CHANNEL

4-CHANNEL

INDUSTRIAL DIVISION **SANBORN CO.** CAMBRIDGE 39, MASS.

RECENT BOOKS *for the* *Product Engineer*

See them
10 days FREE

PROCESS ENGINEERING

By William H. Schutt
Wm. H. Schutt Associates, Detroit

1. This book shows you how to establish the proper sequence of operations and exact labor cost *directly from the blueprint* . . . how to determine the quantity and cost of materials to be used . . . how to plan efficient tools, dies, jigs, and fixtures for economical production. Here's a money-saving book that eliminates guesswork in cost-estimating.

308 pages, $4.50

MACHINE DESIGN

By Paul H. Black
Prof. of Machine Design, Cornell University

2. Here is a complete discussion of each phase of machine designing, from the adaptability and selection of materials for the various machining processes to the elimination of vibration . . . practical aids, hints and suggestions on everything from good form in making machine-design computations to detachable machine fastenings.

Includes Full Treatment of Stress Concentration

Making the book unique is the complete treatment it gives to stress concentration—its applicability—seriousness—mitigation—determination—and design application.

334 pages $5.00

Engineering Applications of
FLUID MECHANICS

By J. C. Hunsaker,
Dept. of Aeronautical Eng., M.I.T.
and B. G. Rightmire,
Dept. of Mech. Eng., M.I.T.

3. Here is an unusually detailed book applying the important basic principles of fluid mechanics to everyday problems. It makes use of advanced, improved methods to analyze problems and equipment involved in fluid flow . . . covers hydraulic circuits and servomechanisms. Here are diagrams, formulas and equations necessary for a complete understanding of fluid mechanics . . . presented in easy-to-follow form for a quick understanding of the principles involved.

487 pages $6.50

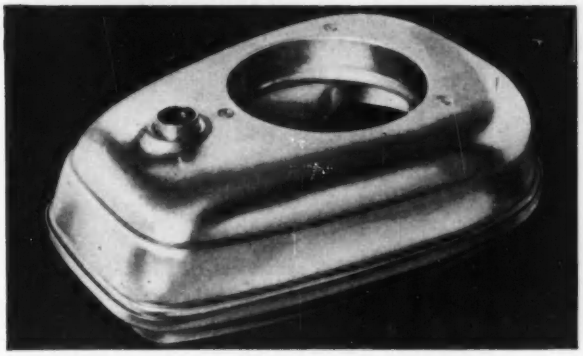
10 DAYS' FREE EXAMINATION

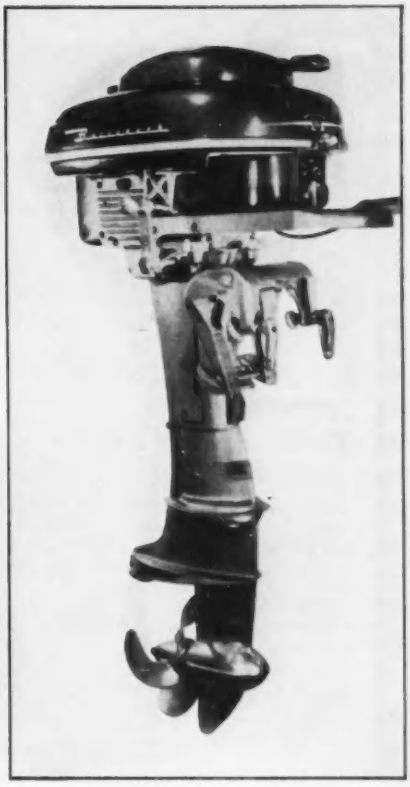
McGraw-Hill Book Co., Inc., 330 W. 42d St., NYC 18
Send me book(s) corresponding to the numbers encircled below for 10 days' examination on approval. In 10 days I will remit the price of the book(s) I wish to keep, plus a few cents delivery charge and return unwanted books postpaid.*

1 2 3

Name .....
Address .....
City ..... Zone.... State .....
Company .....
Position FPE-11-51
* SAVE! We pay mailing costs if you send cash with this coupon. Same return privilege.

Gale Products gas tank being assembled for furnace brazing.





IMPROVE YOUR PRODUCT, CUT TIME-COSTS WITH ALUMINUM!

Gas tanks on Buccaneer outboard motors manufactured by Gale Products of Galesburg, Illinois, are not only lighter, handsomer, more durable—*they are easier, less costly to build,* thanks to aluminum!

These all-aluminum tanks are about *one-third lighter than steel*—with the strength for rugged, outdoor use!

They are more durable, for aluminum is more *corrosion-resistant than steel*—a "natural" where petroleum products are used!

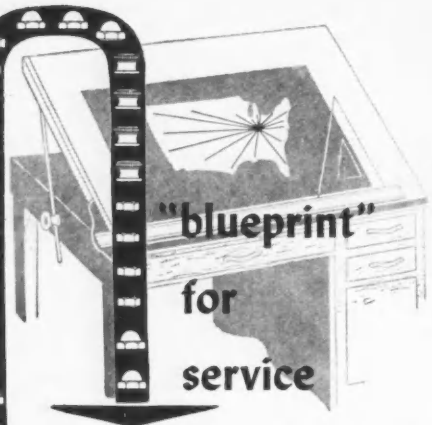
Aluminum tanks cost less to fabricate because aluminum is *more formable*—inexpensive to handle compared to steel!

By employing a *mass brazing technique* not feasible with steel, Gale eliminates expensive hand welding methods, lowers finishing costs. And brazing gives a more attractive appearance at the joints.

Let a Kaiser Aluminum engineer help you determine if aluminum is the answer to *your* design or production problems. No obligation or cost for his services. Kaiser Aluminum & Chemical Sales, Inc., Oakland 12, California. 65 sales offices and warehouse distributors in principal cities.

Kaiser Aluminum

Setting the pace—through quality and service



"blueprint" for service

PLANNED TO HELP SOLVE YOUR BRASS NUT PROBLEMS

A network of Fischer representatives covers the United States, Canada and Cuba...ready to assist you on any specific brass nut problem. You'll find their names and locations in the "Fischer File," another free Fischer service designed to ease your specifying job.

Send Today for your

Fischer File of

"Fischer Turned" BRASS NUTS

Here's a bound file that you'll use constantly. Its 16 pages are filled with charts on Pitch Diameter Tolerances, explanations of American and Unified Thread Limits, complete specifications and drawings of standard brass nuts plus other time-saving, work-saving data. Send for your free copy today.

MAIL THIS COUPON TODAY!

Fischer SPECIAL MFG. CO.
"Turned Products Since 1905"
CINCINNATI 6, OHIO

Send me the new "Fischer File."

Name_____ Company_____

Address_____

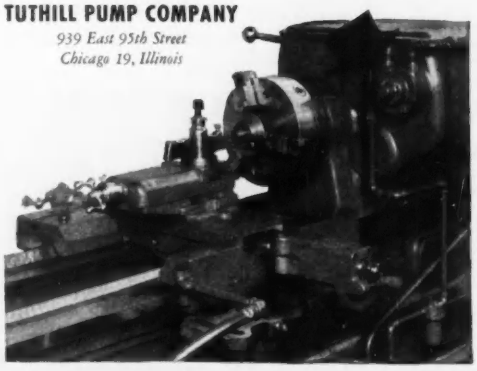
City_____ Zone_____ State_____

HOW TO BUILD THE PUMP INTO YOUR OWN EQUIPMENT

...with TUTHILL Stripped Pumps

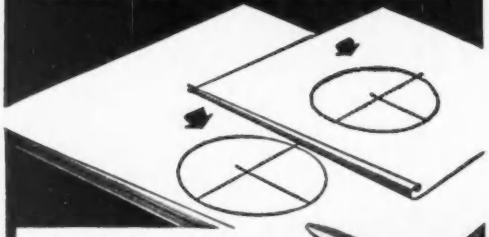
This typical installation shows how Tuthill Stripped Pumps can help you save space, material and money by incorporating the pump directly into the design of your equipment. Ideal in lubrication, coolant, and hydraulic service. Write for Tuthill Stripped Pump bulletin.

TUTHILL PUMP COMPANY
939 East 95th Street
Chicago 19, Illinois



Imperial

TRACING CLOTH THAT DEFIES TIME



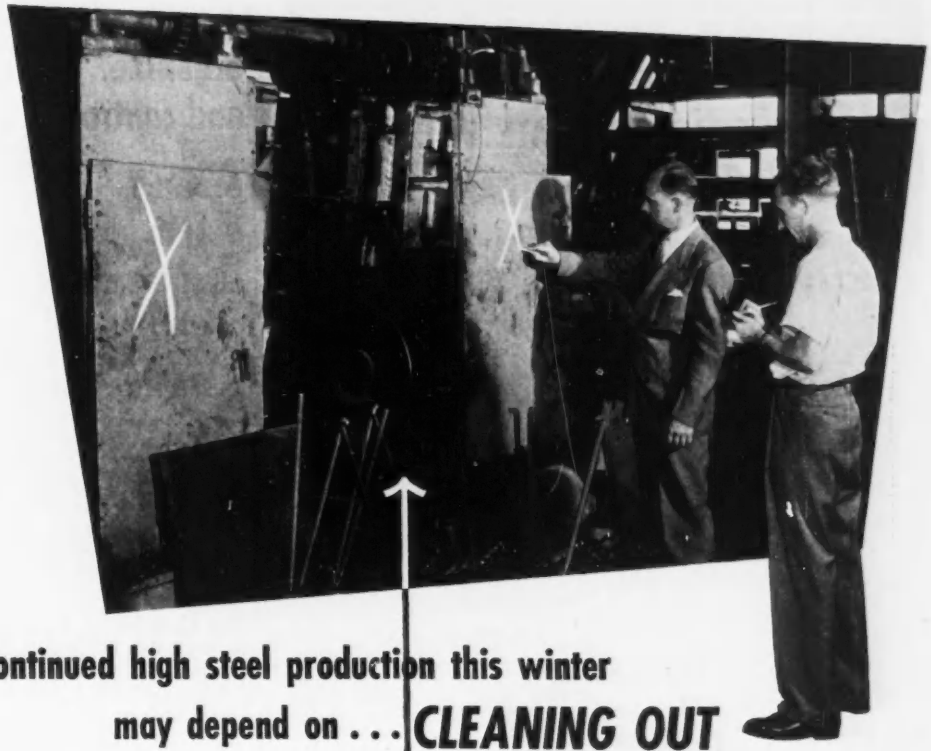
• The renown of Imperial as the finest in Tracing Cloth goes back well over half a century. Draftsmen all over the world prefer it for the uniformity of its high transparency and ink-taking surface and the superb quality of its cloth foundation.

Imperial takes erasures readily, without damage. It gives sharp contrasting prints of even the finest lines. Drawings made on Imperial over fifty years ago are still as good as ever, neither brittle nor opaque.

If you like a duller surface, for clear, hard pencil lines, try Imperial Pencil Tracing Cloth. It is good for ink as well.

Imperial
TRACING CLOTH

SOLD BY LEADING STATIONERY AND DRAWING MATERIAL DEALERS EVERYWHERE



Continued high steel production this winter may depend on . . . CLEANING OUT → YOUR SCRAP THIS MONTH

HOW TO TURN SCRAP INTO MONEY with an organized dormant scrap round-up in your plant:

1. Appoint a top executive with authority to make decisions to head the salvage drive.
2. Organize a Salvage Committee and include a member from every department.
3. Survey and resurvey your plant for untapped sources of dormant scrap. Encourage your employees to look for miscellaneous scrap and report it to the committee.
4. Sell your entire organization on the need to scrap unusable material and equipment.
5. Prepare a complete inventory of idle material and equipment. Tag everything not in use.
6. Start it back to the steel mills by selling it to your regular scrap dealer.
7. **KEEP AT IT!**

***DORMANT SCRAP** is any obsolete, broken or worn-out and irreparable machinery, tools, equipment, dies, jigs or fixtures, etc., that may encumber your premises.

Despite . . . and because of . . . the continued high rate of steel production, the steel industry is on a hand-to-mouth basis in its receipts of purchased scrap . . . *essential to production!* Mills that normally inventory a 60 day supply of scrap, are now maintaining high production with less than a week's supply on hand. *That the effect of winter on transport facilities could quickly exhaust these dangerously meager scrap inventories . . . and thus force a cut in steel production . . . is obvious.* Help assure an uninterrupted steel supply by rounding up and selling your dormant scrap* to your regular scrap dealer *this month!*

INLAND

INLAND STEEL COMPANY

38 South Dearborn Street • Chicago 3, Illinois

SHOCK-RESISTANT RIGIDIZED METAL CASES GUARD DELICATE VOLTAGE STABILIZERS FROM DAMAGE

Rigidized Metals

THE 3 DIMENSIONAL METAL THAT HELPS CONSERVE MATERIALS

To protect delicate mechanisms inside Voltage Stabilizing equipment, the Doelcam Corporation, Newton, Massachusetts, employed three-dimensional design-strengthened, textured Rigidized Metals in the covers, front and rear panels, and amplifier chassis deck. Specially strengthened for increased flexural rigidity and impact resistance, Rigidized Metals allow gage reductions that help CONSERVE CRITICAL MATERIALS. Minimizing both shocks and dents, the surfaces of this versatile metal need little maintenance, offer top protection. Durability, versatility, metal conservation—you get all three in one exclusively manufactured metal. Get the facts on how Rigidized Metals can increase the value of your product.

Pattern 5-WL used on Doelcam Voltage Stabilizers

WRITE on your company letterhead for a copy of the RIGIDIZED METALS CONSERVATION HANDBOOK today

U. S. & FOREIGN PATENTS

Rigidized Metals Corporation

67311 OHIO STREET BUFFALO 3, N. Y.
Offices in Principal Cities in U. S. A. and Canada

How to organize, operate and control a product-design engineering department

Here is a book that will show you tested methods to facilitate production and reduce costs in your engineering department. Designed to minimize paperwork without sacrificing control, this book outlines the basic functions necessary to all successful engineering departments, large and small. These fundamentals are discussed in full to clearly point the way to smoother operation, higher production and greater economy in your organization.

ENGINEERING ORGANIZATION AND METHODS

by JAMES E. THOMPSON

Consulting Industrial Engineer; Formerly Chief Engineer Buell Manufacturing Corporation; Administration Engineer, The Ryan Aeronautical Company

337 Pages, 6 x 9, $4.50

McGraw-Hill Industrial Organization and Management Series

This practical guide analyzes each step of procedure used by successful engineering departments to handle prime functions and establish basic control. In its fifteen chapters you are led through a complete study of your problems relative to organization, personnel, cost control, drawings, part numbering, cataloging, print control and many other important subjects. It explains methods found superior in delegating authority, apportioning duties and avoiding overlapping between sections. Over 150 charts and diagrams assist you in clearly understanding the methods described. The information in this book applied to your organization will result in maximum efficiency and cost reduction.

15 Helpful Chapters:

1. Organization
2. Operation
3. Personnel
4. Cost Control
5. Planning
6. Standards
7. Drawing and Report Numbering
8. Drawing Forms and Title Blocks
9. Drawing Release
10. Drawing Print Control
11. Advance Engineering Information
12. Drawing Changes
13. Technical Services
14. General Services
15. Fundamentals of Engineering Management

10 Days FREE Examination—Mail Coupon

McGraw-Hill Book Co., 330 W. 42 St., NYC 18

Send me Thompson's ENGINEERING ORGANIZATION AND METHODS for 10 days' examination on approval. In 10 days I will send $4.50, plus a few cents postage, or return book postpaid. (Postage paid on cash orders.)

Name .....

Address .....

City and State .....

Company .....

Position PPE-11-51

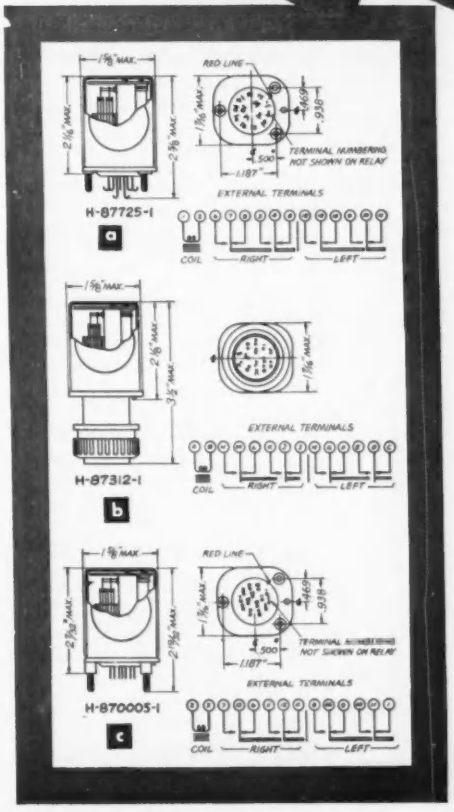
Books sent on approval in U. S. and Canada only.

Nothing can touch them!

these tiny Class "S" Relays from

Automatic Electric

are HERMETICALLY SEALED



To give your product high performance standards, use relays that meet *aviation's* highest standards. These Automatic Electric Class "S" Relays meet them all!

small, light-weight—mount in any position in a restricted space...save valuable room, hold down weight.

resist shock and vibration—contact operation is dependable at vibration up to 10.5 G's.

protected from harmful conditions—operate in "ideal" atmosphere of dry nitrogen, sealed against dust, corrosion, atmospheric pressure changes and tampering.

versatile in application—as shown at left, Class "S" Relays are available with solder-or socket-type terminals...and with the contact arrangements *you* specify.

Other telephone-type relays can also be supplied, with or without hermetically sealed enclosures. Write for circulars. Address: AUTOMATIC ELECTRIC SALES CORPORATION, 1033 West Van Buren St., Chicago 7, Ill. In Canada: Automatic Electric (Canada) Ltd., Toronto. *Offices in principal cities.*

RELAYS SWITCHES

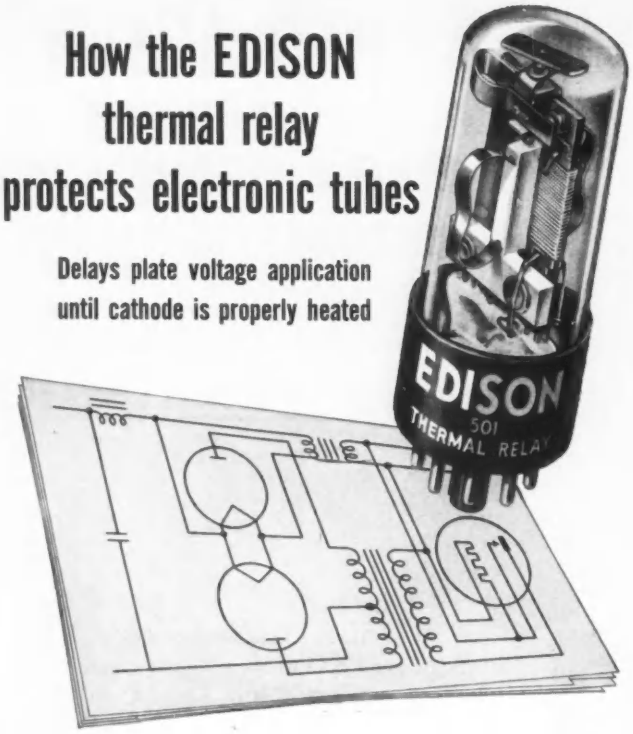
PRODUCTS OF THE INDUSTRIAL DEPARTMENT OF

AUTOMATIC ELECTRIC

CHICAGO

How the EDISON thermal relay protects electronic tubes

Delays plate voltage application until cathode is properly heated



PROTECTION OF CATHODES in electronic tubes, such as thyratrons and gas filled rectifiers, depends on allowing cathodes to reach operating temperature rather than delaying application of plate voltage for a fixed time. A thermal relay, since its operation also depends on attaining a predetermined temperature, is eminently suitable for cathode protection.

THE EDISON THERMAL RELAY is widely used for this purpose because **(a)** its delay characteristics vary with line voltage as does cathode heating; **(b)** it is suitable for continuous operation; **(c)** it offers sustained accuracy; **(d)** it has a wide range of delay periods; **(e)** it is silent and positive in operation; **(f)** it is as independent of ambient temperatures as the cathode it is protecting; **(g)** it is relatively inexpensive; **(h)** it is small and lightweight. The cooling rate of the EDISON Thermal Relay prevents loss of equipment operating time due to momentary power interruptions.

EDISON ENGINEERS will help you solve your cathode protection problems if you will write and give them the data.

Just address Instrument Division, THOMAS A. EDISON, Incorporated, 94 Lakeside Ave., West Orange, New Jersey.

Thomas A Edison
INCORPORATED
Instrument Division • West Orange, New Jersey

OTHER INSTRUMENT DIVISION PRODUCTS

Sealed Time Delay Relays • Sensitive Relays • Electronic Temperature Controls • Critical Temperature Monitors • Electrical Resistance Bulbs.

YOU CAN ALWAYS RELY ON EDISON

A handy reference on formulas for...

- **STRESS**
- **STRAIN**
- **STRENGTH**

of materials

HERE'S your ideal guidebook on strength of materials. It contains extensive tables of formulas and numerous illustrative examples . . . includes the results of intensive analytical and experimental work . . . presents for your quick reference all the formulas for stress, strain, and strength useful to the design-engineer. It also brings you—*step-by-step*—the essential principles used in stress analysis, and provides you with fundamental data on the mechanical properties of materials.

Formulas for Stress and Strain

By RAYMOND J. ROARK

Professor of Mechanics, University of Wisconsin

366 pages, 6 x 9, 43 illustrations

SECOND EDITION, $5.00

PRODUCT DEVELOPMENT SERIES

This practical book takes you from basic definitions through clear statements of general principles, and right on to facts, figures and formulas for the calculation of stress and deflection. You get everything from the principles of superposition and least work to formulas for elastic stability of plates and shells.

Check the partial list of tables this guide puts at your fingertips:

- **—for straight beams, circular rings and flat plates under a wide variety of conditions of loading and support**
- **—for curved beams and torsion members of various sections**
- **—for thin- and thick-walled pressure vessels**
- **—for rollers and other bodies under direct pressure**
- **—for columns**
- **—for slender bars and thin plates in which failure occurs through elastic instability.**

SEE IT 10 DAYS—FREE

McGraw-Hill Book Co., Inc., 330 W 42d St., N. Y. 18

Send me Roark's FORMULAS FOR STRESS AND STRAIN for 10 days' examination on approval. In 10 days I will remit $5.00, plus a few cents for delivery, or return the book. We pay for delivery if you remit with this coupon; same return privilege.

Name .....

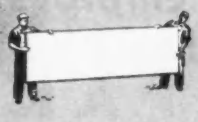
Address .....

City ..... Zone.... State.....

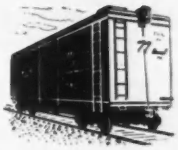
Company .....

Position FPE-11-51

Books sent on approval in U. S. and Canada only.



LARGE PANEL SIZE



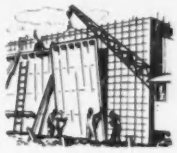
Over 100,000 Railroad Cars Have Plywood Siding and Lining

EASY TO WORK

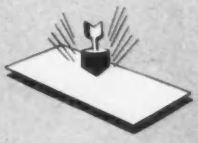
Plywood Simplifies Pattern Work; Offers Design Adaptability

Low-Cost Plywood Bins Are Easy To Build, Give Long Service

LIGHT WEIGHT

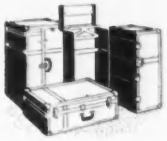


Re-Usable Plywood Concrete Forms Speed Work, Lower Job Costs

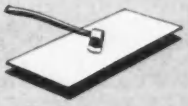


PUNCTURE-PROOF

GREAT STRENGTH

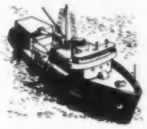


Plywood Boxes for Luggage Lend Strength, Light Weight



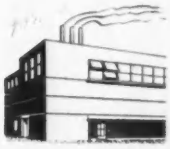
SPLITPROOF

Long-lived Plywood Shipping Cases Are Light, Strong, Re-Usable



Durable Exterior Plywood Builds Sea-Going Fishing, Work Craft

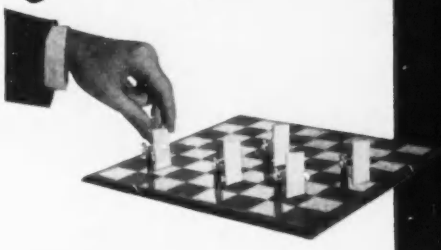
DIMENSIONALLY STABLE



Big Plywood Panels Speed Work On Building and Remodeling Jobs

NATURAL BEAUTY

Smart Move!



● Checkmate *your* production problem! Here's a versatile, economical, fast-to-work, hard-to-hurt material that can help *you right now!* Whether you need a material to speed work on a plant or a product, a tough, all 'round packaging and maintenance material or a dependable alternate for critical metals . . . make the *smart* move—to plywood. For information or technical assistance on special problems, write: (USA Only) Douglas Fir Plywood Association, Dept. 459, Tacoma 2, Wn.

Douglas Fir

Plywood

AMERICA'S BUSIEST BUILDING AND INDUSTRIAL MATERIAL

50-TON Contour-Former employs GIANT NOPAK Cylinder

Built by the Cyril Bath Co., Cleveland O., this powerful machine is used to shape curved aluminum airplane fuselage parts. A NOPAK Model "A" 10" x 80" Hydraulic Cylinder . . . operating at 1500 P.S.I. . . . works in conjunction with the forming die, mounted on a gear-driven turntable, to stretch-form an infinite number of curved structurals . . . with 700 different dies now in use.

Very likely the efficiency of machines you build or use can be stepped up substantially through the correct use of NOPAK Valves and Cylinders.

GALLAND-HENNING MFG. CO.
2762 S. 31st St., Milwaukee 46, Wisconsin

Representatives in Principal Cities

Refer to Sweet's File for Product Designers or write for Bulletin SW-1

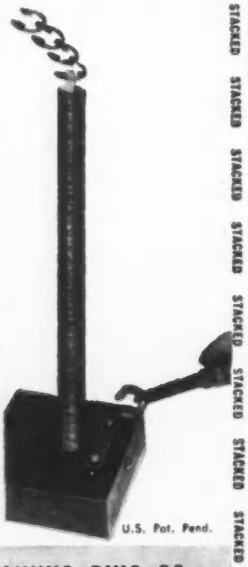
NOPAK
VALVES AND CYLINDERS
DESIGNED for AIR and HYDRAULIC SERVICE

STACKED STACKED STACKED STACKED STACKED STACKED STACKED

NOW...
INDUSTRIAL RETAINING RINGS STACKED

for modern dispensing and speedy application

Open type retaining rings packed in neat stacks... dispensed one-at-a-time... completely eliminate ring loss...speed production... cost no more than jumble-packed rings. Industrial's specially designed base and tool are free with initial order. Send today for our illustrated brochure.



U.S. Pat. Pend.

INDUSTRIAL RETAINING RING CO.
originators of Modern Dispensing
6 WEST SIDNEY AVENUE • MOUNT VERNON, NEW YORK

THIS PART WAS INVESTMENT CAST IN ONE PIECE!

INVESTMENT CAST SAE 1020

Here is an example of a part best conceived and designed as an INVESTMENT CASTING. Note the intricate contours, cast holes, and over-all complexities. As an INVESTMENT CASTING, this conveyor bracket has inherent structural strength combined with minimum weight. Our engineers are ready to help you take advantage of INVESTMENT CASTING'S inherent savings in machine and setup time, tooling costs, design changes, etc. Call us as you reach the blueprint stage.

Send for booklet

INVESTMENT CASTING CO.
319 CHESTNUT ST. NEWARK 5, N. J.
Precision Castings

Uniform "proofing" for bakeries assured by Multi-Purpose THERMOSTAT

3 THERMOSWITCH thermostats control air in Anets Rack "Proof" Box. Thermostat (a) controls air temperature, thermostat (c) with wick acts as humidity control, and thermostat (b), set at 75 F, is wired in series with thermostat (c) to prevent moisture injection with resultant condensation and flooding when starting cold box.

Proper control of the "proof" box is a very important factor in commercial baking. These boxes "proof," or raise, yeast-type doughs by means of warm, humid air that is kept at a pre-determined temperature and humidity. This air must not only be held consistently to requirements, but must also be controlled in such a way that condensation is prevented when box is turned on.

To accomplish this, Anetsberger Brothers, makers of Anets proof boxes, chose Fenwal THERMOSWITCH thermostats. In successful operation on these boxes for more than ten years, these thermostats maintain conditioned air with laboratory accuracy. Operating on 24 volts A.C., they regulate temperature and humidity of air with such precision that bakeries can depend on uniform "proofing."

Low cost, compact, precise THERMOSWITCH thermostats solve many types of control problems. Easy to install, easy to maintain, they operate on a unique principle that permits effective control of many variables where heat is a factor. Their activating control element is the single-metal shell that expands or contracts instantaneously with temperature changes, making or breaking the totally enclosed electrical contacts.

Find out now how Fenwal THERMOSWITCH units can help you. Mail coupon today.

"Visit our Booth 603 at the Chemical Industries Exposition, Grand Central Palace, New York"

Fenwal

THERMOSWITCH®

The Precision, Multi-Purpose, Thermostat Control

SENSITIVE . . . *but only to heat*

FREE! **Get this bulletin . . . see what Fenwal THERMOSWITCH Units can do for you.**
Just fill in coupon and mail . . . no obligation.

FENWAL, INCORPORATED, 211 Pleasant St., Ashland, Mass.
111 South Burlington Ave., Los Angeles 4, Cal.
TEMPERATURE CONTROL ENGINEERS

Name ..... Position .....
Company .....
Street .....
City ..... Zone State .....

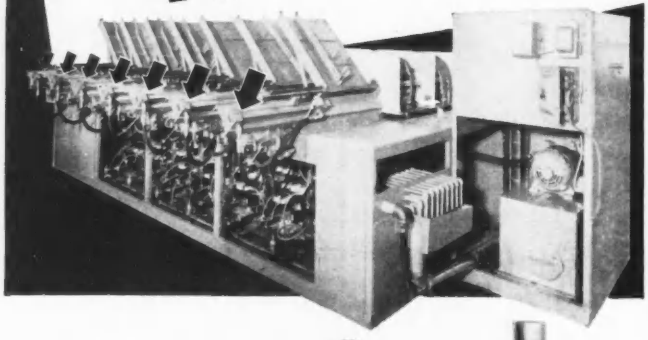
I am chiefly interested in the applications checked:

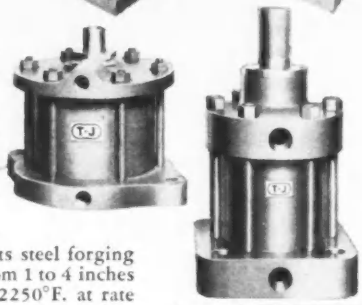
- ☐ Heating
- ☐ Cooling
- ☐ Humidity Control or Detection
- ☐ Alarm (over-temperature, under-temperature)
- ☐ Vapor Control
- ☐ Timing (thermal)
- ☐ Radiant Heat Control
- ☐ Pressure Control (by controlling vapor temperature)

OTHER (Please fill in your special requirements) .....
.....
.....

Job File No. 3259

Feeds Automatically WITH T-J CYLINDERS



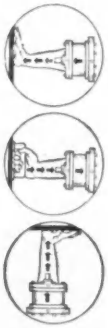


T-J Hydraulic Cylinders furnish efficient, automatic "push power" for feeding devices in this new Ajax-Northrup induction forge heating equipment.

This unit—manufactured by Ajax Electrothermic Corp., Trenton, N. J.—automatically heats steel forging stock in sizes ranging from 1 to 4 inches (rounds or squares) at 2250°F. at rate of 7500 to 8500 lbs. per hour. Has space for 8 heating stations . . . each with *hydraulically operated billet feeding devices employing T-J Cylinders.* These cylinders also eject heated bars automatically. Induction heating with this equipment results in uniformity of successive billets fed to the forge—thus controlling quality of finished forgings and reducing rejects.

Do you have a tough job in power movement—pushing, pulling or lifting? Let T-J help you *simplify machines, save labor* and *cut costs* by using T-J Air or Hydraulic Cylinders! Many standard sizes and styles . . . cushioned or non-cushioned . . . 100 lb. or 50,000 lb. Precision-built, long life. Write for more information. The Tomkins-Johnson Co., Jackson, Mich.

FOR POWER MOVEMENT IN ANY DIRECTION



100 LBS. or 50,000 LBS.

35 YEARS EXPERIENCE

TOMKINS-JOHNSON

RIVITORS . . . AIR AND HYDRAULIC CYLINDERS . . . CUTTERS . . . CLINCHORS

T-J

There's a girl in our office . . .

. . . Whose one job is to expedite delivery of your requests for "New Catalogs and Bulletins to the manufacturers concerned.

The job keeps her busy, too. She handles several thousand requests from PRODUCT ENGINEERING readers every month. And she's anxious to be of service to you whenever she can.

So check the "New Catalogs and Bulletins" insert if you haven't already done so. You'll find a lot of useful information listed there . . . and any of it is available to you promptly and without cost.

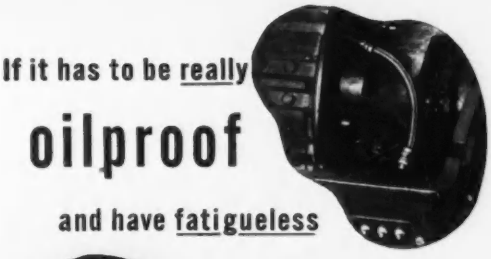
PRODUCT ENGINEERING

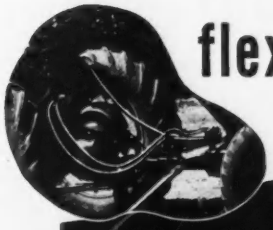
If it has to be really

oilproof

and have fatigueless

flexibility...





USE

RESISTOFLEX HOSE ASSEMBLIES

There's nothing to fatigue in Resistoflex hose – not the synthetic rubber jacket, the high grade yarn braiding, nor the compar tube.

And no gumming, eroding or swelling from oil either. For the compar tube is impervious to water-insoluble oils and compounds. The compar tube also adds more than necessary strength for medium pressures and shock loads in hydraulic systems.

For years, many well known companies have standardized on Resistoflex Hose Assemblies to assure minimum line troubles and replacements. You, too, will find that Resistoflex quality pays off in the long run. Write for specification sheets.

For out of the ordinary engineering with synthetics

RESISTOFLEX

CORPORATION

Belleville 9, New Jersey

YOUR'S for the asking . . .

75 Years' Experience in MOLDED PLASTICS

. . . and the Trained Minds that go with it!

AUBURN offers you a background of *75 years continuous operation* in the molded plastic field, plus the experience, skill, and specialized talents that go with it — for the asking.

AUBURN salesmen are an example of what experience teaches. They are *sales engineers*, not agents, experienced in both design and production . . . qualified for technical discussion with your design and engineering personnel.

Every Modern Molding Method

AUBURN molds any plastic material by any modern molding method. Briefly, our facilities include:

- ***Compression Molding*** — 30 ton to 500 ton capacity
- ***Injection Molding*** — 4 oz. to 22 oz. capacity
- ***Transfer Molding*** — 75 ton to 325 ton capacity
- ***Extrusion*** — 1½" to 3½"
- ***Automatic Rotary*** — Lauterbach machines for high volume compression molding
- ***Reinforced Plastics*** — Performing and pressing equipment for sizes up to 40" x 50"

Dependable Subcontractor

Approved for production of classified material, AUBURN is a dependable subcontractor. Complete tool and die making facilities are maintained, with a highly skilled staff long experienced in the problems of mold design and volume production methods.

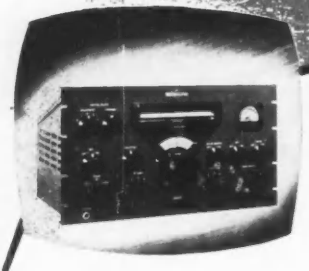
For the complete story of AUBURN, write for illustrated booklet.

Auburn Button Works, Inc.

350 McMaster Street, Auburn, New York

Founded in 1876. Telephone 3-5320

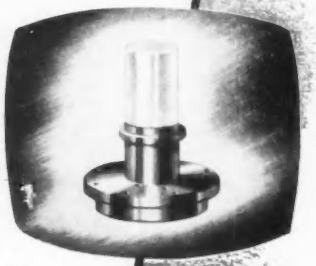
JK CRYSTALS



Supplying TODAY'S NEEDS

They're "anchors to the airwaves", these JK crystals which pinpoint the RIGHT frequencies. Like much of today's fine equipment, this Collins communications receiver prefers the JK H-9.

and DESIGNING TOMORROW'S



So new their possibilities remain comparatively unexplored, JK ultrasonic transducers have become the youngest pioneers in laboratory research. They are supplied in any cut desired.

A MODERN THERMOMETER FOR OIL FIELDS

Deep in the oil fields, the JK ultrasonic transducer has found another dramatic application. It is used to measure temperatures far into the depths of the ground. When the signal changes frequency below the ground, the temperature is thus recorded. WHATEVER the crystal requirement, James Knights labs can furnish the crystal to do the job.

Crystals FOR THE *Critical*

Critical tolerances and precision work have put James Knights UP FRONT. Their aim: to furnish every type crystal ever made, whether out-of-date or still unheard of. To be sure, consult JK design engineers.

THE JAMES KNIGHTS CO.
SANDWICH 4, ILLINOIS

WRITE for free catalog, listing JK crystals

GET BOTH ECONOMY AND LONG LIFE WITH

*Metal-Cal**

THE PERMANENT, SELF-ADHESIVE IDENTIFICATION DEVICE

If you want to put—and keep—a name or instructions in front of people and do it simply, inexpensively...METAL-CALS are for you!

Consisting of a .003" thickness of aluminum foil anodized, dyed and backed with a high tensile bonding material, a METAL-CAL can be applied easily to any smooth, cohesive surface. No drilling, screws or rivets required!

Once on—a METAL-CAL STAYS on. Letters and characters on its surface remain clear and sharp under the most trying weather and wear . . . live as long as the metal itself.

Use of METAL-CALS has spread rapidly from one industry to another as they prove their over-all superiority to both decals and conventional metal nameplates. For further information and quotations that may prove METAL-CALS the answer to your identification problem, write

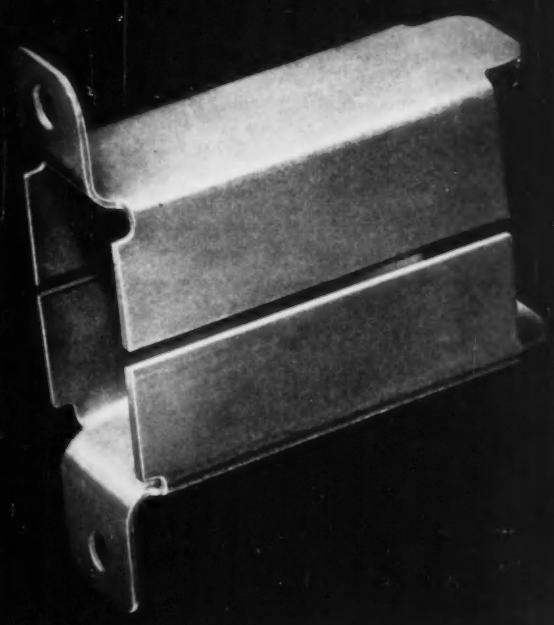
* Trade Mark Registered

Metal-Cal
DIVISION
C & H SUPPLY CO.
Dept. H-1 Boeing Field, Seattle 8, Washington

Sales Office
Wichita, Kas.

Sales Office & Plant
Los Angeles, Calif.

20 million cycles without a solenoid breakdown!



IT'S MADE OF BERYLCO BERYLLIUM COPPER

For safeguarding lives and property, brakes on a hoist are as essential as brakes on a car. Yale & Towne uses solenoids to actuate the brakes of its high-performance electric hoists. An integral part of the solenoid is the plunger guide shown here, made for Yale & Towne by the Instrument Specialties Co.

The plunger is made of laminated silicon steel and tends to exert a filing action on the guide, which is not lubricated. Under severe conditions, the plunger operates at 400 cycles per hour. Other materials tried in this application wore through, stuck, caused downtime and high maintenance costs. Stainless steel, for example, had a life of 250,000 cycles, phosphor bronze a life of 1 million to 2 million. Berylco was still going strong at 20 million cycles, at which point the test was discontinued. Maintenance costs dropped to a phenomenal 0.2% a year, largely due to the use of beryllium copper . . . and, of course, downtime was practically eliminated.

Resistance to wear is only one of the many outstanding properties of versatile **BERYLCO** beryllium copper. Others —such as high conductivity, elasticity and strength—can be obtained alone or in combination, depending upon the alloy selected. It will pay you to investigate what Berylco can do for you. Take advantage of the technical knowledge of the world's largest producer of beryllium copper. Blueprint your problem.

VALUABLE ENGINEERING INFORMATION

on Berylco beryllium copper is compiled in a series of monthly technical bulletins. To receive your copy regularly, write on your business letterhead.

Tomorrow's products are planned today—with Berylco Beryllium Copper.

Sample material available for testing purposes

BERYLCO THE BERYLLIUM CORPORATION

DEPT. 1K, READING 2, PENNSYLVANIA

New York · Springfield, Mass. · Cleveland · Dayton · Detroit · Chicago · Minneapolis · St. Louis · Seattle · San Francisco · Los Angeles

Representatives in principal world-trade centers

SEARCHLIGHT SECTION

EMPLOYMENT • BUSINESS • OPPORTUNITIES • EQUIPMENT—USED or RESALE

UNDISPLAYED RATE

$1.20 per line, minimum 3 lines. To figure advance payment, count 5 average words as a line.

(See ¶ on Box Numbers.)

POSITION WANTED & INDIVIDUAL SELLING OPPORTUNITY undisplayed advertising rate is one-half of above rate, payable in advance.

PROPOSALS $1.20 a line an insertion

INFORMATION

BOX NUMBERS care publication count as 1 line additional in undisplayed advertisements DISCOUNT of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals)

EQUIPMENT WANTED OR FOR SALE Advertisements acceptable only in Displayed Style

DISPLAYED RATES

The advertising rate is $10.50 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request

AN ADVERTISING INCH is measured ⅛ inch vertically on one column, 3 columns—30 inches—to a page

P E

NEW ADVERTISEMENTS received by 10 A. M. November 19th, in the N.Y.C. office, will appear in the December issue, subject to limitations of space available.

California Opportunity for Design Engineer

We have an opening for an experienced engineer in our Research and Development Department. Job calls for inventive capacity as well as sound engineering ability. Experience shou'd be with office machines but similar fields will be considered. This is a permanent job in a fast-growing organization. You will be eligible under our generous insurance, retirement and bonus plans. Your application should be fully detailed, and will be held in confidence.

Friden Calculating Machine Co., Inc.
San Leandro, California

ENGINEER

Mechanical or Electrical

Wanted by Phila. Manufacturer of electronic components for responsible position. Experience required in Design & Production of Precision Parts & Assemblies.

INTERNATIONAL RESISTANCE CO.
401 N. BROAD ST.

WANTED

MACHINE and EQUIPMENT DESIGNERS

With experience by well known machine tool builder located in a progressive New England town. Extensive engineering program under way. Give full details of background and experience.

Write directly to *Mr. M. H. Arms*, Chief Engineer.

BRYANT CHUCKING GRINDER CO.
Springfield, Vermont

ELECTRICAL STANDARDS ENGINEER

Graduate engineer with work experience in electrical-mechanical measuring laboratory. Position will involve set-up of qualification systems to determine & maintain accuracy of production measuring equipment. Supervisory responsibility for Jr. Quality Control personnel.

INTERNATIONAL RESISTANCE CO.
401 N. Broad St.
PHILA. 8, PA.

ELECTRIC RANGE ENGINEER

Mechanical or electrical engineer—preferably between the ages of 30 and 40—with experience in the technical development and manufacturing of domestic electric ranges.

For application write

Manager, Professional Employment
WESTINGHOUSE ELECTRIC CORP.
Educational Department, East Pittsburgh, Pa.

DO YOU HAVE THE QUALIFICATIONS TO FILL THIS

POSITION of OPPORTUNITY?

YOU must be

- an experienced — 5 to 15 years — first class product development engineer or special machine designer
- ingenious, resourceful and liking diversification
- capable of taking on product development from scratch to conclusion
- willing to accept a wide latitude of endeavor and responsibility.

If you feel you are the man we need and desire a permanent position—not just an emergency defense job—write today to:

P-2007, Product Engineering
330 W. 42nd St., New York 18, N. Y.

WANTED

Engineers and Physicists with educational background in mechanical, electrical, or electronic engineering, physics or engineering physics for research and advanced development in plant and laboratory instrumentation, geophysics, physical measurements and industrial electronics. Prefer men with five to fifteen years' experience in experimental research, design and development of instruments, intricate mechanisms, electronic apparatus, optical equipment, servomechanisms and allied fields. Positions are of immediate and permanent importance to our operations. Southwestern location in medium-sized community; excellent employee benefits. Please give age, experience, and other qualifications in reply.

Personnel Director,
Research and Development Dept.
PHILLIPS PETROLEUM COMPANY
Bartlesville, Oklahoma

QUALITY ENGINEER

Graduate E.E., to act in advisory capacity for Quality Control Department. Duties involve determination of quality problems which can be expected to occur in manufacturing process. Applicant needs background of experience in product control & electronic component manufacture.

P-40, P. O. BOX 8552
Phila. 22, Pa.

DESIGN AND DEVELOPMENT ENGINEERS

Several graduate mechanical engineers with 1 to 10 years experience in development of small mechanical devices, valves or valve specialties, wanted by the Chicago Factory of Minneapolis-Honeywell Regulator Company.

Position offers opportunity for extensive use of technical knowledge and ingenuity on development of a variety of mechanical control devices. There are good permanent positions with opportunities for advancement, and with salary proportionate to ability.

Minneapolis-Honeywell Regulator Co.
2301 N. Knox Avenue Chicago 39, Illinois
Attention: W. W. VOSS

YOU can live in North Georgia's famous, bracing, all-year enjoyable climate . . .

- Year round sports
- 8 Miles from Atlanta—Gateway to the South
- 20 minutes from new Allatoona Dam, famed for fishing and water sports
- 30 minutes from 8 fine public golf courses, including the one designed by the immortal Bobby Jones
- 60 minutes from the scenic beauty of the Blue Ridge Mountains
- YOU and your family can enjoy the famous "Southern Hospitality"—a new joy in living.

YOU can begin a NEW CAREER,
with unexcelled opportunities for the future.

YOU can SERVE YOUR COUNTRY
by becoming an important part of its defense activities.

All this YOU can do—if you can qualify for opportunities now open in LOCKHEED'S Georgia Division long-range production program.

GET IN ON THE GROUND FLOOR IN THESE KEY POSITIONS:

Manufacturing Engineers
Industrial Engineers
Mechanical Engineers
Aeronautical Engineers
Electrical Engineers
Design Engineers
Liaison Engineers
Engineering Draftsmen
Tool Designers
Tool Planners
Tool & Die Makers
Stress Analysts
Radio and Radar Technicans
Tool Inspectors
Process Analysts
Other Aircraft Manufacturing Experience

Write today to

MR. FRANK J. JOHNSON
EMPLOYMENT MANAGER
394½ PEACHTREE ST., N. E.
ATLANTA, GEORGIA

LOCKHEED
AIRCRAFT
CORPORATION
GEORGIA DIVISION
MARIETTA, GEORGIA

DOORWAY INTO PLASTICS

The man we want may already be in the plastics field and looking for a better opportunity—or he may be seeking to enter this field. Probably between 30 and 35 years of age, he has a scientific background—not necessarily a degree but a good foundation in science or engineering. Knowledge of chemistry or chemical engineering desirable but not a "must". "Musts" include: (1) a sales personality—he likes to meet people and win them to his way of thinking; (2) ambition that will spur him to extraordinary effort; (3) the patience, persistence and confidence to override the delays and setbacks inevitable in sales development work. For this man the doorway is open to a career in plastics with a leading manufacturer of raw materials—a well established, fast growing company whose past record promises well for the future of its employees. Your letter, which should give full details of education and business or professional experience, will be acknowledged and treated in confidence.

P-2191, Product Engineering
330 W. 42 St., New York 18, N. Y.

MECHANICAL DESIGN SUPERVISOR

We have a rare opportunity for an ingenious mechanical designer to step into a position which will challenge his whole creative ability. He will be delegated responsibility for product design. He will coordinate the efforts of retained designers until the time he has selected and trained a staff of competent subordinates, and then the mechanical design function will be under his direction. He and his group will design new mechanical products and redesign the old. This man must be a graduate engineer and have a proven history of original mechanical designs, particularly in mechanisms. Five to ten years' experience doing design and development work on products such as automatic machinery, packaging machinery or as a consultant in a design company would be appropriate. We are a 106 year-old company and are the established leader in bowling and billiards. Ours is a multi-plant operation with young, progressive management. This opening is in our main plant in Muskegon, Michigan, a modern city of 100,000 where you will find good housing and friendly neighborly living on the shores of Lake Michigan. Address replies to

J. W. Edmunds
The Brunswick Balke Collender Company
623 S. Wabash Ave., Chicago 5, Illinois

BRONZE CASTINGS

SAND

- Up to 150 lb. pcs. closely held to standards.
- Bench work or production runs. Rough or machined. Over forty years experience.
- American Non-Gran Bronze Co., Berwyn, Pa.

PRECISION MACHINE WORK
NON-GRAN
CASTINGS · SAND & CENTRIFUGAL

Write for "Our Story in Pictures"

SPECIAL SERVICES

RESEARCH KINEMATICIAN, M.S. in M.E., versatile, inventive, thorough scientific knowledge and diversified experience in analysis and synthesis of mechanisms of any kind (linkages, cam drives, intermittent mechanisms etc. as applied in different branches of machinery) carries out research and development work on specific kinematic problems. SS-2326, Product Engineering.

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42nd St. (18)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITIONS VACANT

HELP WANTED: The Taylor-Winfield Corporation, 1052 Mahoning Avenue, N. W., Warren, Ohio, a leading electric resistance welder and electronic control manufacturer, has five openings for Design Engineers in their Mechanical Engineering Department. These are permanent positions, provided men selected prove they have the necessary skill and ability. Men with resistance welding design experience are preferred. However, recent mechanical engineering graduates will be given careful consideration. The work is 100% board work, involving the design of electric resistance welder machines and component parts such as jigs and fixtures used in conjunction with this type equipment. Experience or training in electro-mechanical machinery would be a definite asset in meeting the job requirements. Interested applicants should write the Personnel Department stating age, education, experience, salary expected and other pertinent data.

THE TECHNION (Institute of Technology), Haifa, Israel, proposes to appoint a Professor of Production Engineering. Applicants should have first-rate professional and academic qualifications, be willing to integrate themselves into the life of the country and, in due course, to teach in Hebrew. Applications with full details should be sent, for transmission to Haifa, to: The American Technion Society, 154 Nassau Street, New York 38, N. Y.

WANTED, DESIGNER draftsman, top quality, experienced in sheet metal design for commercial refrigerated cases, refrigerators, etc. Permanent position with old nationally known manufacturer in small town near city in Michigan, Indiana, Ohio area. Good working and living conditions. Salary in mid four figure range. Write fully. References will not be checked without permission. P-2147, Product Engineering.

YOUNG ENGINEERING Graduate, preferably with degree in metallurgy, who would like to make advertising writing his career. Large progressive corporation noted for excellent employee-relations has opportunity in advertising department. Ultimate duties will include trade magazine advertising copy, technical and sales promotional literature. The man we want has a good practical imagination. He can tell about engineering practices in clear, simple words. Above all he likes to write. If you believe you are this man, tell us all about yourself in a letter. If you cannot qualify, but know a man who can, do us both a favor and suggest that he write us. All replies confidential. Our staff knows of this advertisement. Address P-2301, Product Engineering.

EMPLOYMENT SERVICE

SALARIED POSITIONS $3,500 to $35,000. We offer the original personal employment service (established 41 years). Procedure of highest ethical standards is individualized to your personal requirements. Identity covered; present position protected. Ask for particulars. R. W. Bixby, Inc., 268 Dun Bldg., Buffalo 2, N. Y.

SALARIED PERSONNEL $3,000-$25,000. This confidential service, established 1927, is geared to needs of high grade men who seek a change of connection under conditions assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited. Jira Thayer Jennings, Dept. H, 241 Orange St., New Haven, Conn.

POSITIONS WANTED

ENGINEER, AGE 32, B.S.M.E.; M.S.E. Cornell Univ. Licensed mech. engr. 8 years successful experience on design, research and development of diversified heavy machineries and process equipments. Capable and efficient. Desire permanent position as assistant chief engineer, project engr. or research and development engr. at medium and small industrial manufacturers. PW-2233, Product Engineering.

MECHANICAL ENGINEER, 17 years experience on medium and large automatic machines; from scratch to finished design; stress and kinetic analysis; intricate mechanical, oil hydraulic, pneumatic and electrical components. Also tool design and shop experience. Five years in charge of small engineering department. PW-2311, Product Engineering.

"Opportunity" Advertising:
Think
"SEARCHLIGHT"
First

PROFESSIONAL SERVICES

GEORGE H. KENDALL
Consulting Mechanical Engineer
Cost Reduction Studies: Process or Product.
Redesign Existing Products for Greater Profit.
Trouble Shooting Production, Design, Cost Problems.
Specialist Automatic Machinery, Process, Controls.
New Developments, Patent Studies, Investigations.
New Products & Process Engineering Studies.
P. O. Box 3 (Est. 1923) Tel. Darien 5-1504
Noroton Heights Darien, Connecticut

NEW YORK TESTING LABORATORIES, INC.
CHEMICAL, MECHANICAL, ELECTRICAL METALLURGICAL ENGINEERS
ANALYTICAL CHEMISTS, PHYSICISTS, X-RAY
Analysis, Tests of all Materials and Products, Plant and Field Services in Special Measurements of Stress, Sound, Vibration and other. Consultants in Litigation and Process Engineering and Design
80 Washington St. New York City 6, N. Y.

SKINNER, HARLAN AND IRELAND, INC.
Consulting Engineers
Specializing in Magnetic Materials and Their Application
Office and Laboratory Indianapolis 7, Indiana

POSITIONS WANTED

PRODUCT ENGINEER: engineering executive 20 yrs. design & development experience on small electro-mechanical devices. Several patents. Tool & production experience. New Ch. Eng. of med. small plant. PW-7295, Product Engineering.

PRODUCTION ENGINEER. Tool and Die maker with 35 years practical experience in the manufacture of small and medium sized electrical parts. Capable designer of special production equipment, blanking, progressive and drawing dies, tools and jigs. Excellent supervisor, patient instructor. 5 years M.E. schooling. Seeks position where ability to perform and direct, knowledge of machine set-up for quantity production, cost, time, and routing are the prime consideration. Would consider locating anywhere, the South preferred. Top Salary Only. PW-2100, Product Engineering.

PATENTS

CONSULT: Z. B. POLACHEK,
Reg. Patent Attorney, 1234 Broadway, New York 1, N. Y.

LEGAL NOTICE

STATEMENT OF THE OWNERSHIP, MANAGEMENT, AND CIRCULATION REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946 (Title 39, United States Code, Section 233)

Of Product Engineering published Monthly at Albany, New York, for October 1, 1951.

1. The name and address of the publisher, editor, managing editor, and business manager is: Publisher, McGraw-Hill Publishing Company, Inc., 330 West 42nd St., New York 18, N. Y.; Editor, G. F. Nordenholt, 330 West 42nd St., New York 18, N. Y.; Managing Editor, Y. H. Laughner, 330 West 42nd St., New York 18, N. Y.; Business Manager, R. T. Douglas, 330 West 42nd St., New York 18, N. Y.

2. The owner is: McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York 18, N. Y.; Stockholders holding 1% or more of stock: Curtis W. McGraw and Donald C. McGraw, Trustees for Harold W. McGraw, Curtis W. McGraw and Donald C. McGraw, all of 330 West 42nd Street, New York 18, N. Y.; Curtis W. McGraw and Harold W. McGraw, Trustees for Catherine M. Rock, 330 West 42nd Street, New York 18, N. Y.; Curtis W. McGraw, 330 West 42nd Street, New York 18, N. Y.; Donald C. McGraw, 330 West 42nd Street, New York 18, N. Y.; Mildred W. McGraw, Madison, New Jersey; Grace W. Mehren, 536 Arenas Street, LaJolla, California; Touchstone & Company, c/o The Pennsylvania Company, 15th and Chestnut Streets, Philadelphia 1, Pa.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: None.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

McGRAW-HILL PUBLISHING COMPANY, INC.
By J. A. GERARDI, Vice Pres. & Treas.

Sworn to and subscribed before me this 6th day of September, 1951.
[SEAL] ELVA G. MASLIN
(My commission expires March 30, 1952)

Index of

PRODUCTS ADVERTISED

In This Issue

•

MATERIALS

Adhesives 79
Aluminum Alloys..2, 101-102, 104, 267, 328-329, 330, 437
Beryllium Alloys 449
Bimetal 104, 252, 338, 347
Brass 2, 95, 243, 332
Bronze...95, 223, 243, 328-329, 332, 393, 414
Carbon 278, 380
Carbon Graphite 12-13, 36, 278
Cemented Carbides 270
Ceramics 302
Chemicals 8
Copper Alloys 15, 99, 104, 223, 243, 328-329, 347, 449
Cork Compositions 18
Fabrics, Coated or Impregnated 354
Fibre 379
Friction Materials....221, 296, 432
Glass 280, 379, 403
Graphite 380
Laminated Metals....104, 286, 338
Leather 72-73, 214
Light Metals 440
Liquids Heavy 44
Manganese Alloys 104, 414
Molybdenum Alloys 398
Nickel Alloys.....38, 98, 243, 338
Nylon 62, 416
Plastics..8, 10, 23, 51, 61, 62, 204, 247, 261, 274, 305, 309, 318, 331, 340-341, 370-371, 413, 428, 447, 459
Plastics, Laminated 327
Platinum Alloys 104
Plywood 443
Powdered Metals...12-13, 36, 275, 278, 347, 386
Resins 61
Rubber & Synthetics..8, 31, 72-73, 214, 249, 261, 273, 280, 289, 326, 342, 358, 360, 413, 422
Silicones 202, 280, 342
Silver Alloys 104, 243
Stainless Steel..2nd cover, 75, 108, 114, 206
Steel.....75, 82, 206, 225, 365, 439
Titanium Alloys 4
Tool Steel 366
Wood 443
Zinc 285

STRUCTURAL PARTS

Bars 75, 332, 439, 449
Bushings 271, 380
Castings..90, 107, 223, 267, 292-293, 320-321, 330, 378, 380, 399, 409, 412, 414, 444
Die Castings....204, 239, 241, 259, 350, 409
Expanded Metals 424
Extrusions..101-102, 273, 328-329, 331, 336, 428, 447
Forgings.....291, 292-293, 414, 418
Metal Powder Parts....12-13, 36, 221, 275, 347, 380, 386
Plates 439, 447
Rods.....2, 95, 223, 328-329, 416, 428, 447, 449
Shapes.....2, 82, 223, 243, 273, 328-329, 336, 355, 363
Sheets..2nd cover, 2, 101-102, 273, 439, 447
Stampings..243, 282, 286, 319, 392, 394, 423, 432
Strips..2nd cover, 95, 273, 338, 365, 416, 428, 439, 449
Tubing..2nd cover, 2, 32, 66, 75, 81, 86, 88, 95, 101-102, 205, 223, 225, 273, 294, 320-321, 328-329, 355, 363, 416, 428, 430
Wire.....16, 95, 338, 392, 449

FINISHES

Galvanizing 375
Metal Spraying 375
Paints & Lacquers....84, 281, 322, 349, 396
Plating 362, 392
Rust Proofing...281, 362, 425, 435
Sealants 396

MECHANICAL PARTS

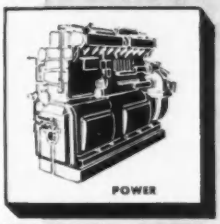
Abrasives 221
Adhesives 79, 354
Bearings, Ball, Roller, and Needle.....4th cover, 30, 54-55, 69, 83, 85, 96, 118, 231, 364, 271, 351, 390, 394, 419, 429

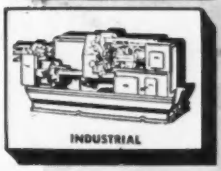
(Continued on page 454)

ROPER

ROTARY PUMPS

The Name of Dependability





Widely Used in Diversified Industries

Whether your equipment is dependent upon a pump for fuel transfer, coolant work, or hydraulic action, you will maintain greater operating efficiency with the rugged Roper — Series F. This series is built to pump clean liquids of all kinds, and is available in standard or special-built designs in 1 to 300 g.p.m. . . . pressures to 300 p.s.i.

Standard-fitted pumps are self-lubricated by the liquid being pumped . . . helical gears of equal size run smoothly in axial hydraulic balance . . . precision ground and hardened drive shaft . . . 4-port design permits eight optional piping arrangements to cut down installation time and costs. Investigate dependable Roper pumps now and learn how they can help you in new or replacement installations. Send the coupon today!

SEE OUR CATALOG IN SWEET'S

ROPER Rotary Pumps

GEO. D. ROPER CORPORATION

381 Blackhawk Park Avenue, Rockford, Illinois

☐ *Please Send Catalog 951*

☐ *Have a Roper Representative Call*

NAME_____

ADDRESS_____

CITY_____

COMPANY_____

NEWARK "End-Shāk" TESTING SIEVE SHAKER

Motion is important in making sizing tests. Conforms to recommendations for the motion to be used when making hand tests, issued by the Bureau of Standards.

Here, in the Newark "End-Shāk" unit, you get proper sustained hand motion mechanically. You get the best motion without being subjected to any human variation or weakness. This sturdy testing machine holds up to 7 full height sieves or up to 13 half height sieves. It is designed for 8 inch diameter sieves. Standard ½ HP., 110-220 volt 60 cycle, 1750 rpm motor supplied. Special motor to order.

We'll be glad to send you prices and descriptive literature. And if you will outline your testing requirements we'll be glad to suggest the proper sieve series to use.

NEWARK for ACCURACY

Newark Wire Cloth COMPANY

351 VERONA AVENUE • NEWARK 4, NEW JERSEY

Philadelphia 3, Penna. 1311 Widener Bldg. San Francisco, Calif. 3100 19th St. Chicago, Ill. 20 N. Wacker Dr. New Orleans, La. 820 Maritime Bldg. Los Angeles, Calif. 1100 So. Alameda St. Houston, Texas P. O. Box 1970

Index of PRODUCTS ADVERTISED In This Issue

(Continued from page 453)

Bearings, "Oil-less" . . . 12-13, 36, 275, 278, 380
Bearings, Sleeve . . . 12-13, 36, 83, 264, 278, 332, 347, 380, 393, 399
Bellows . . . 26, 39, 352
Belts . . . 8, 15, 19, 89, 91, 221, 264, 289, 373, 406, 462
Bolts, Nuts, Screws and Rivets 41, 45, 105, 227, 260, 279, 283, 286, 288, 308, 336, 350, 372, 376, 380, 407, 420, 427, 431
Brakes . . . 14, 99
Bushings & Grommets . . . 271, 275, 332, 347
Carburetors . . . 426
Chains . . . 11, 50, 76-77, 290, 344-345, 431, 432
Clamps . . . 92-93, 304, 388
Clutches . . . 99, 100, 264, 266, 412, 418
Collars . . . 227
Compressors . . . 19, 248
Containers . . . 253, 406, 440
Controls . . . 318, 381, 382, 388, 408, 415
Counters . . . 17
Couplings, Flexible . . . 83, 268, 290, 344-345, 348, 420, 432, 456
Couplings, Hose & Tube . . . 81, 92-93, 251, 304
Dampers . . . 244
Drivers . . . 11, 19, 20-21, 27, 50, 53, 63, 70, 99, 266, 290, 344-345, 362, 382, 412, 433
Engines . . . 240, 292-293, 346
Fasteners . . . 35, 37, 41, 45, 105, 116, 227, 229, 243, 260, 279, 283, 286, 288, 308, 336, 350, 372, 376, 380, 407, 414, 420, 427, 431, 438
Feeders . . . 213
Filters . . . 80, 318, 372, 388, 426
Flexible Joints . . . 245
Floats . . . 238
Gages & Instruments . . . 233, 299, 366, 404, 420
Gears . . . 6, 63, 83, 112, 263, 272, 282, 284, 381, 385, 398, 406, 408, 412, 420, 428, 433, 434
Handles . . . 414
Hose . . . 8, 81, 91, 221, 289, 352, 358, 447
Hydraulic & Pneumatic Equipment . . . 1, 22, 60, 213, 248, 256, 257, 266, 280, 292-293, 303, 318, 323, 354, 366, 368, 372, 386, 388, 397, 408, 417, 444, 446, 458
Insulation . . . 360
Locks, Hinges . . . 411
Lubricating Equipment . . . 65, 239, 269, 281, 333
Materials Handling . . . 15, 56-57, 58-59, 292-293, 417, 431
Mountings . . . 244, 456
Name Plates . . . 264, 346, 408, 448
Packing, Gaskets, Seals . . . 8, 12-13, 18, 36, 71, 72-73, 92-93, 214, 221, 246, 249, 251, 258, 269, 278, 280, 302, 304, 342, 358, 360, 364, 380, 415, 432, 459, 460
Photographic Equipment . . . 295
Pins . . . 41, 105, 227, 414
Piping . . . 225, 233, 320-321
Plugs . . . 227
Power Units . . . 22, 248, 256-257, 323, 368, 397, 408, 417, 446
Pumps . . . 19, 56-57-58-59, 60, 89, 248, 256-257, 299, 323, 326, 354, 366, 368, 386, 397, 398, 400, 415, 417, 420, 438, 453, 458
Rings . . . 12-13, 36, 278, 280, 302, 444, 460
Riveting Machines . . . 446
Rolls . . . 358
Scales . . . 56-57-58-59, 315
Screens . . . 372, 415
Shafts . . . 410
Sheaves & Pulleys . . . 19, 264
Shims . . . 286
Speed Reducers & Motor Reducers . . . 3rd cover, 20-21, 27, 53, 63, 70, 83, 89, 99, 264, 316-317, 335, 381, 385, 433, 434
Spindles . . . 217
Springs . . . 52, 94, 236, 313, 423
Sprockets . . . 11, 50, 83, 282, 290, 432
Strainers . . . 372
Testing Equipment . . . 233, 250, 292-293, 299, 366, 374, 420
Tapes . . . 326
Thermometers . . . 204
Timers . . . 428

Index of PRODUCTS ADVERTISED

In This Issue

Transmissions . . . 11, 19, 20-21, 27, 264, 362, 382, 412, 432
Traps . . . 233, 238
Universal Joints . . . 83, 418
Valves & Fittings . . . 1, 233, 238, 251, 256-257, 346, 354, 358, 372, 388, 413, 444, 457, 458
Vibratory Equipment . . . 415
Vibration Dampers . . . 244, 360, 456
Washers . . . 249, 275, 282, 347, 358
Wire Cloth . . . 48, 406, 454

ELECTRICAL PARTS

Brakes . . . 306-307
Brushes . . . 12-13, 36, 278, 380
Coils . . . 276, 422
Connectors . . . 40, 49
Contacts . . . 4, 49, 104, 106, 235, 338
Controls & Control Equipment . . . 4, 24-25, 42-43, 46-47, 64, 67-68, 89, 99, 106, 219, 235, 240, 250, 254-255, 260, 262, 278, 297-298, 302, 337, 353, 356, 367, 382, 383-384, 387, 395, 396, 410, 415, 441, 445, 457
Cords . . . 273, 314
Counters . . . 356
Electronic Equipment . . . 40, 219, 240, 276, 315, 366, 374, 448
Fans & Blowers . . . 367
Generators . . . 28-29, 421
Heating Units . . . 277, 326, 387
Instruments . . . 250, 276, 315, 366, 374, 377, 421, 436
Insulators . . . 302, 318
Lamps . . . 434
Magnets . . . 369
Motors . . . 3rd cover, 24-25, 28-29, 33-34, 56-57-58-59, 74, 87, 89, 97, 109, 242, 250, 312, 316-317, 335, 339, 357, 361, 367, 376, 392, 394, 401-402, 406, 421
Rectifiers . . . 415
Rings . . . 251
Solenoids . . . 262, 318, 358, 395, 457
Telephones . . . 276
Thermostats . . . 39, 78, 302, 442, 445, 457
Timers . . . 74, 250, 336, 356, 392, 394, 428
Transformers . . . 276, 361
Vibrators . . . 4
Wire & Cable . . . 204, 314
Wiring Accessories . . . 310-311, 314, 394

DRAFTING ROOM EQUIPMENT AND SUPPLIES

238, 248, 265, 295, 300-301, 396, 405, 434, 438

FABRICATING METHODS AND SERVICES

Assembling . . . 340-341
Bending . . . 292-293
Boring . . . 292-293
Brazing . . . 372
Drawing . . . 375
Enameling . . . 375
Extruding . . . 249, 261, 331, 336, 358
Feeding . . . 415
Finishing . . . 340-341
Forming . . . 103, 375, 392
Gear Cutting . . . 6
Honing . . . 389
Molding . . . 8, 211, 249, 261, 273, 274, 289, 299, 302, 318, 326, 331, 340-341, 358, 370-371, 410, 422, 447, 461
Planing . . . 292-293
Plating . . . 372
Pressing . . . 299
Rolling . . . 355
Shearing . . . 372
Spinning . . . 312
Stamping . . . 282, 372, 375, 392, 432
Swaging . . . 76-77
Turning . . . 292-293
Weighing . . . 415
Welding . . . 4, 106, 237, 334, 359, 372, 375, 435

ENGINEERING AND PRODUCTION SERVICES

103, 268, 277, 287, 355, 359, 375, 391, 418

BOOKS

308, 324-325, 400, 410, 424, 426, 436, 440, 442

Can any of these free services help you speed defense production?

New York State offers these aids to defense manufacturers and suppliers

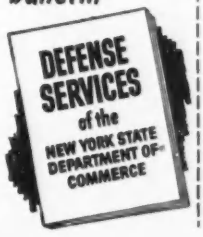
1. Help in Locating Subcontractors. The New York State Department of Commerce, through its "Industrial Preparedness Survey," can supply complete data on plants and equipment suitable for production of specific defense items. A prime contractor can speedily locate the subcontractor he needs.

2. New Plant Site Location. To help you establish new plants or expand current operations, the Department will be glad to recommend appropriate locations available within the State. Information on labor, raw materials, power, water, fuel and transportation will aid your decision. Inspection trips are arranged confidentially.

3. Office in Washington. A New York State office is maintained in the nation's capital to help New York businessmen. This office sets up meetings with the proper personnel; provides information on government agencies; keeps abreast of current regulations and restrictions; aids in preparing applications and other papers needed to carry on business with Federal agencies.

4. Information on Current Federal Purchasing. As part of its service to businessmen, New York State screens notices of Federal procurement opportunities and circulates procurement information to firms within the State.

Write for bulletin



New York State Department of Commerce
Room 117, 112 State St., Albany 7, N. Y.

Please send me a copy of your free bulletin "Defense Services of the New York State Department of Commerce."

*Name*_____

*Position*_____

*Company*_____

*Street*_____

*City*_____ *State*_____

The primary function of LORD Mountings is to isolate vibration. When this is accomplished machines and equipment operate with higher efficiency . . . run smoother, quieter . . . service life is lengthened. Personnel fatigue is reduced . . . production increased . . . scrap losses diminished . . . maintenance costs lowered.

All these important factors mean added sales appeal, and you will improve your product sales appeal by eliminating costly, nerve-racking vibration and noise. LORD Mountings protect equipment from either internal or external vibration.

Vibration-control should be planned as an integral part of your product. LORD Engineers will assist you to most effectively adapt flexible mountings to your designs . . . select mountings of proper type, size, and deflection . . . position the mountings for greatest effectiveness.

Whether you make sensitive instruments or massive machinery, it will be to your advantage to make LORD Vibration-Control part of design. For improved product sales appeal, bring your vibration problems to LORD . . . Headquarters for Vibration-Control.

LORD MANUFACTURING COMPANY, ERIE, PA.

LORD BONDED RUBBER

Vibration-Control Mountings
. . . Bonded-Rubber Parts

INDEX TO ADVERTISERS

This index is published as a convenience to the readers. Every care is taken to make it accurate, but PRODUCT ENGINEERING assumes no responsibility for errors or omissions.

Accurate Spring Mfg. Co. 313
Adel Division, General Metals Corp. 354
Advance Pressure Castings, Inc. 259
Airborne Accessories Corp. 412
Aircraft-Marine Products Co. 310-311
Alfax Paper & Engineering Co. 434
Alemite 65
Allegheny Ludlum Steel Corp. 108
Allen-Bradley Co. 297-298
Allied Research Products Corp. 362
Allis-Chalmers Mfg. Co. 89
Allis-Chalmers Mfg. Co., Tractor Div. 346
Allmetal Screw Products Co., Inc. 260
Alumicast Corp. 409
Aluminum Industries, Inc. 267
Ambroid Co. 354
American Brass Co. 243
American Chemical Paint Co. .. 281
American Emblem Co., Inc. 408
American Engineering Co., Hydraulics Div. 417
American Fort-Pitt Spring Div., H. K. Porter Co., Inc. 236
American Hard Rubber Co. ... 261
American Insulator Corp. 211
American Manganese Bronze Co. 414
American Metal Hose Branch, American Brass Co. 81
American Smelting & Refining Co. 223
American Steel & Wire Co. ... 16, 52
American Welding & Mfg. Co. 359
Amoco Metal, Inc. 328, 329
Anchor Coupling Co., Inc. 92-93
Anti-Corrosive Metal Products Co., Inc. 288
Arkwright Finishing Co. 265
Armco Steel Corp. 206
Armstrong Cork Co. (Gaskets, Packings & Seals) 18
Arrow-Hart & Hegeman Electric Co. 67-68
Arrowhead Rubber Co. 280
Art Wire & Stamping Co. 392
Arwood Precision Casting Corp. 412
Atlas Powder Co. 322
Auburn Button Works, Inc. ... 447
Automatic Electric Sales Corp. 441
Automotive Gear Works, Inc. 263

Bakelite Co. A. Div. Union Carbide & Carbon Corp. 10
Baldwin-Hamilton Corp., Testing Div. 292-293
Barber-Colman Co. 406
Barco Mfg. Co. 245
Barnes Co., Wallace, Div. Associated Spring Corp. 94
Barry Corp. 244
Bead Chain Mfg. Co. 76-77
Belden Mfg. Co. 314
Belgian Electric Sales Corp. ... 339
Beryllium Corp. 449
Bethlehem Steel Co. 82
Blood Brothers Machine Co. ... 418
Bond, Inc., Charles 434
Boston Gear Works 83
Boston Woven Hose & Rubber Co. 91
Bound Brook Oil-less Bearing Co. 275
Bridgeport Brass Co. 95
Brown & Sharpe Mfg. Co. 366
Bruning Co., Inc., Chas. 405
Bundy Tubing Co. 294
Bunting Brass & Bronze Co. ... 332

C & H Supply Co. 448
Cambridge Wire Cloth Co. 406
Carboloy Co., Inc. 270
Carlyle Johnson Machine Co. ... 100

INDEX TO ADVERTISERS

Carpenter Steel Co. 114
Carpenter Steel Co., Alloy Tube Div. 88
Cash Valve Mfg. Corp., A. W. 346
Chace Co., W. M. 252
Cherry Rivet Co., Div of Townsend Co. 407
Chicago Metal Hose Corp. 352
Chicago Rawhide Mfg. Co. 214
Chicago Thrift-Etching Corp. 346
Ciba Co., Inc., Araldite Div. .. 61
Clare & Co., C. P. 337
Clark Controller Co. 353
Cleveland Cap Screw Co. 308
Cleveland Worm & Gear Co. ... 53
Clifford Mfg. Co. 26
Climax Molybdenum Co. 398
Columbia Steel Co. 16, 52, 66
Connecticut Hard Rubber Co. .. 342
Conoflow Corp. 408
Continental Screw Co. 283
Corning Glass Works 403
Coto-Coil Co., Inc. 422
Cramer Co., Inc., R. W. 250
Crane Co. 233
Crane Packing Co. 258
Cullman Wheel Co. 432
Cuno Engineering Corp. 80

Dayton Rogers Mfg. Co. 432
Dayton Rubber Co. 373
Denison Engineering Co. .. 256-257
Dial Light Co. of America 434
Diamond Power Specialty Corp 219
Diefendorf Gear Corp. 408
Dings Brakes, Inc. 306-307
Dixie Cowdrey Machine Corp. 418
Dodge Mfg. Corp. 264
Doerr Electric Corp. 312
Douglas Fir Plywood Assn. 443
Dow Chemical Co. 44, 51
Dow Corning Corp. 202
Driv-Lok Pin Co. 414
Drop Forging Association 291
DuPont de Nemours & Co., Inc., E. I. (Neoprene) 31
DuPont de Nemours & Co., Inc., E. I. (Plastics) 62
Durakool, Inc. 260
Durez Plastics & Chemicals, Inc. 247
Dynamatic Corp., subs. Eaton Mfg. Co. 99

Eagle Signal Corp. 355
Earle Gear & Machine Co. 406
Eastman Kodak Co., Industrial Photographic 295
Eaton Mfg. Co., Dynamatic Corp. 99
Eaton Mfg. Co., Foundry Div. 107
Edison Co., Thomas A. 442
Elastic Stop Nut Corp. of America 105
Electric Auto-Lite Co. 204
Electric Boat Co., Electro Dynamic Div. 97
Electro Dynamic Div., Electric Boat Co. 97
Electro Products Laboratories 276
Elliott Co. 28-29
Emerson Electric Mfg. Co. 367

Faber-Castell Pencil Co., A. W. 360
Fafnir Bearing Co. 351
Fairbanks-Morse Co. ..56-57-58-59
Fairfield Mfg. Co. 284
Farrel-Birmingham Co., Inc. ... 385
Federal Bearings Co., Inc. 55
Federal Mogul Corp. (Equipment) 347
Felt Products Mfg. Co. 432
Fenwal, Inc. 445
Fischer Special Mfg. Co. 438
Flynn Mfg. Company, Michael 336
Foote Bros. Gear & Machine Corp. 63
Foote Gear Works, Brad. 112
Friez Instrument Div., Bendix Aviation Corp. 414
Fulton Sylphon Div., Robertshaw-Fulton Controls Co. 39
Funk Aircraft Co. 412

(Continued on page 458)

Send for your copy of this

CATALOG TODAY!

60 pages of valuable information describing the line of Honeywell Industrial Controls

THE KIND of information you want, right at your finger tips . . . on pneumatic, electric and electronic non-indicating controls for temperature, pressure and humidity.

Included are many types of switches and relays . . . temperature and pressure controllers . . . many types of valves . . . and scores of other inexpensive, accurate and dependable controls.

Catalog No. 8304 is complete and factual . . . contains detailed specifications for all products, with complete supplementary price lists. It belongs in your files for ready reference . . . send for your copy today.

Also ask to be put on the mailing list for *Industrial Control News*—a periodical publication devoted to new and unusual applications of automatic controls throughout industry. It is written by and for production and maintenance men. Articles are illustrated by drawings and photographs and graphically show how jobs can be made easier, costs reduced and operating efficiency increased.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4459 Wayne Ave., Phila. 44, Pa.

MINNEAPOLIS **Honeywell**

Brown Instruments

80% of all leading lift truck manufacturers use...

HYDRECO VALVES

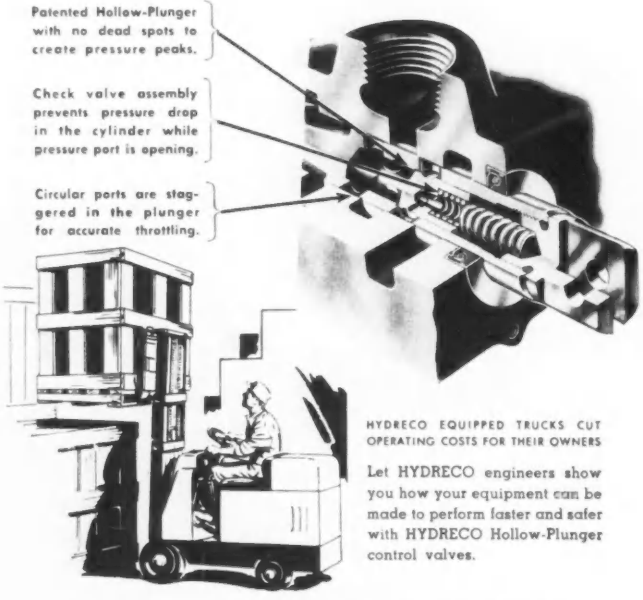
—for smooth and accurate control of raising, tilting, and accessory operations.

HYDRECO Hollow-Plunger control valves build in the fast and safe control so necessary to proper lift truck operation. Accurate throttling characteristics, inherent in HYDRECO valves, cut out lost motion in picking up and stacking. Built-in check valves of the Hollow-Plunger design entirely eliminate momentary load drops and jerky operations. There are no dead spots in HYDRECO valve operation to create pressure peaks, damaging to the hydraulic system.

Patented Hollow-Plunger with no dead spots to create pressure peaks.

Check valve assembly prevents pressure drop in the cylinder while pressure port is opening.

Circular ports are staggered in the plunger for accurate throttling.



HYDRECO EQUIPPED TRUCKS CUT OPERATING COSTS FOR THEIR OWNERS

Let HYDRECO engineers show you how your equipment can be made to perform faster and safer with HYDRECO Hollow-Plunger control valves.

HYDRAULIC EQUIPMENT COMPANY

1112 EAST 222nd STREET • CLEVELAND 17, OHIO

INDEX TO ADVERTISERS

(Continued from page 457)

Galland-Henning Mfg. Co. 444
Garlock Packing Co. 364
Gast Mfg. Corp. 248
General American Transportation Corp., Plastics Div. ... 340-341
General Electric Co., Apparatus Dept. 33-34
General Radio Co. 374
Gerbing Mfg. Corp. 362
Gering Products, Inc. 428
Gerotor May Corp. 368
Geuder, Paeschke & Frey Co., Contract Div 375
Gits Bros. Mfg. Co. 269
Gleason Works 6
Goodrich Co., B. F. (Rivnut) 45
Goodrich Chemical Co., B. F. (Hycar) 8
Graton & Knight Co. 460
Gray Iron Founders' Society Inc. 378
Great American Industries, Inc., Rubatex Div. 360
Gries Reproducer Corp. 350
Groen Mfg. Co. 287
Groov-Pin Corp. 350
Gurley, W. & L. E. 404

Hannifin Corp. 22
Hansen Mfg. Co., Inc. 394
Hardchromers, Inc. 392
Harper Co., H. M. 372
Haydon Co., A. W. 336
Haydon Mfg. Co., Inc. 392
Heatbath Corp. 396
Heim Co. 96
Hercules Powder Co., Inc. ... 309
Holliston Mills, Inc. 238
Holtzer-Cabot Co., Division of National Pneumatic Co., Inc. 109
Houghton & Co., E. F. 72-73
Howard Industries, Inc. 242
Hyatt Bearings Div., General Motors Corp. 85
Hydraulic Equipment Co. 458

Imperial Tracing Cloth Co. ... 438
Indiana Gear Works 428
Indiana Steel Products Co. ... 369
Industrial Retaining Ring Co. 444
Inland Steel Co. 439
International Nickel Co., Inc. MONEL 38
International Nickel Co., Inc. NICKEL ALLOY 98
International Packings Corp. ... 460
Investment Casting Co. 444

Johns-Manville Corp. (Ind. Friction Materials) 296
Johnson Bronze Co. 393
Johnson Machine Co., Carlyle 100

Kaiser Aluminum & Chemical Corp. 437
Kaydon Engineering Corp. 231
Keuffel & Esser Co. 300-301
Knights Co., James 448
Koh-I-Noor Pencil Co., Inc. ... 396
Kollsman Instrument Corp. ... 421
Koppers Co., Inc. (Fast's Coupling) 348
Koppers Co., Inc., Plastics Div. 305
Koven & Bro., Inc., L. O. 391
Kraissl Co. 400
Kurz-Kasch, Inc. 370-371

Lamb Electric Co. 335
Laminated Shim Co., Inc. (Laminum) 286
Lamson & Sessions Co. 41
Lapeer Mfg. Co. 388
Laplant-Choate Mfg. Co., Inc. 323
Leach Relay Co. 396
Leland, Inc., G. H. 262
Lewellen Mfg. Co. 382
Lincoln Electric Co. 237
Linde Air Products Co., Unit of Union Carbide & Carbon Corp. 435
Linear Inc. 302

INDEX TO ADVERTISERS

Link-Belt Co. 11, 15, 27, 30
Lord Mfg. Co. 456

McGill Mfg. Co., Inc. 390
McGraw-Hill Book Co., Inc. ... 308
McGraw-Hill Catalog Service .. 400
Madison-Kipp Corp. 239
Magnetic Amplifiers 240
Mahon Co., R. C. 334
Mallory & Co., Inc., P. R. 4, 106
Manheim Mfg. & Belting Co. ... 462
Marion Electrical Instrument Co. 377
Marman Products Co., Inc. 304
Marsh Corp., Jas. P. 420
Massachusetts Gear & Tool Co. 398
Master Electric Co. (Speed-master) .....3rd Cover
Mead Specialties Co. 213
Mechanical Air Controls, Inc. 372
Meehanite Metal Corp. 90
Metals & Controls Corp., General Plate Div. 104
Metals & Controls Corp., Spencer Thermostat Div. ... 78
Michigan Tool Co., Cone Drive Div. 433
Micro Switch Div., Minneapolis-Honeywell Regulator Co. ...42-43
Miller Motor Co. 303
Mills Corp., Elmer E. 331
Milwaukee Hydropower, Inc. ... 386
Minneapolis-Honeywell Regulator Co. (Industrial Div.) ... 457
Minnesota Mining & Mfg. Co. 79
Monsanto Chemical Co. 23
Moraine Products Div., General Motors Corp. 386
Mt. Vernon Die Casting Corp. 241

National Bearing Div., Amer. Brake Shoe Co. 399
National Motor Bearing Co., Inc. 71
National Screw & Mfg. Co. 431
National Tube Co. 66
Newark Wire Cloth Co. 454
New Departure Div. of Gen. Motors Corp. 118
New Hampshire Ball Bearings 394
New Jersey Zinc Co. 285
New York State, Dept. of Commerce 455
Nicholson & Co., W. H. 238
Norgren Co., C. A. 333
Norma-Hoffman Bearings Corp. 429
North American Aviation, Inc. 304

Ohio Seamless Tube Co. 32
Ohmite Mfg. Co. 383-384
Ortman-Miller Machine Co. 280
Owens-Corning Fiberglas Corp. Electrical Sales Div. 379

Packard Electric Div., Gen. Motors Corp. 357
Palnut Co. 420
Parker Appliance Co. 251
Parker-Kalon Corp. 279, 427
Parker Rust Proof Co. 425
Patton-MacGuyer Co. 394
Peck & Harvey 248
Peerless Electric Co. 376
Penn Metal Co., Inc. 424
Perkins Machine & Gear Co. 272
Pesco Products Co. Borg Warner Corp. 397
Pheoll Mfg. Co. 336
Philadelphia Gear Works 381
Pittsfield Products, Inc. 372
Plastic Research Products Inc. 274
Pneu-Trol Devices, Inc. 388
Polymer Corp. 416
Pope Machinery Corp. 217
Porter Co., Inc., H. K. 236
Precision Tube Co. 430
Product Engineering 110-111
Progressive Mfg. Co. 376
Pure Carbon Co., Inc. 380

(Continued on page 460)

FIRST WITH TEFLON*

Hermetically Sealed Transformer Terminals

(patents pending)

Another excellent example of "Engineered fluorocarbons"—these transformer terminals utilize the United States Gasket Company's exclusive method (Patents Pending) of producing a fused hermetic seal between TEFLON and metals.

These terminals withstand severe mechanical shock and vibration and thermal shock. There is no strain-point as with fused glass-to-metal or ceramics-to-metal seals. They facilitate assembly as there is no danger of breakage. Another of many advantages—complete absence of DC plating.

Throughout industry, materials men are finding TEFLON's unique combination of properties—plus United States Gasket Company *Application Engineering*—the answer to many tough problems.

If you require a material that is inert to all acids, caustics, solvents, mechanically tough, heat resistant, extremely anti-hesive and wear resistant; that has zero water absorption, is unaffected by extreme humidity and fungus; that is an ideal electrical insulator, especially where high and low ambient temperatures and frequency stability are problems; that may be fused to or "alloyed" with metals, carbon, silicate, glass, etc., to open other broad fields of application . . . ask for catalog No. 300 or write stating your problem.

*TEFLON is registered trademark of E. I. duPont de Nemours & Co.

UNITED STATES GASKET COMPANY

FLUOROCARBON PRODUCTS DIVISION

649 N. 10TH STREET, CAMDEN, N.J.

FOREMOST FABRICATORS OF "TEFLON" AND OTHER FLUOROCARBON PLASTICS

SOLVED:

How to make efficient OIL SEALS with fewer metal parts

Oil Seals must be designed for specific jobs.

Improved rubber compounds are being adapted to more efficient sealing. Advanced moulding techniques have kept pace with oil seal design: today the complete seal emerges from the mould with metal and sealing element perfectly bonded, so that multiple metal housings are not required.

G&K-INTERNATIONAL has pioneered many of these advances to meet the needs of speed, material, lubricants, temperature, pressure, *space and assembly*. Making Oil Seals to seal your oil is our business. We can help you.

For Grakone (Synthetic) Bonded OIL SEALS

IPC

AFFILIATED WITH GRATON & KNIGHT COMPANY

INTERNATIONAL PACKINGS CORPORATION

BRISTOL, NEW HAMPSHIRE

GRATON & KNIGHT COMPANY

WORCESTER, MASSACHUSETTS

GRATON AND KNIGHT

Since 1851

100 YEARS OF SERVICE TO INDUSTRY

INDEX TO ADVERTISERS

(Continued from page 459)

R.B.M. Division of Essex Wire Corp. 235
Racine Tool & Machine Co. 326
Ramsey Chain Co., Inc. 290
Raybestos Manhattan Inc., Equipment Sales Div. 221
Raymond Mfg. Co., D v. Associated Spring Corp. 423
Redmond Co., Inc. 87
Reeves Pulley Co. 20-21
Reliance Electric & Engineering Co. 361
Republic Rubber Co., Div. of Lee Tire & Rubber Corp. 289
Republic Steel Corp. Steel & Tube Div. 225
Resistoflex Corp. 447
Revere Copper & Brass Inc. 2
Reynolds Metals Co., Aluminum Div. 101-102
Reynolds Wire Div., National Standard Co. 48
Rhodes, Inc., M. H. 428
Rigidized Metals Corp. 440
Rockford Clutch Div., Borg-Warner 418
Roll Formed Products Co. 355
Rollway Bearing Co., Inc. 419
Roper Corp., Geo. D. 453
Ross Operating Valve Co. 1
Roth Rubber Co. 422

Sanborn Co. 436
Schatz Mfg. Co. 54
Scintilla Magneto Div., Bendix Aviation Corp. (Electrical Connectors) 49
Scovill Mfg. Co. (Industrial Fasteners) 380
Servo-Tek Products Co. 350
Sessions Clock Co., Tyni-Switch Div. 64
Sewall Mfg. Co., E. B. 282
Sharon Steel Corp. ..... 2nd Cover
Shaw Insulator Co. 318
Shenango-Penn Mold Co. 330
Sherwin-Williams Co. 349
Sier Bath Gear & Pump Co. 420
Simmons Fastener Corp. 35
Skinner Electric Valve Div., The Skinner Chuck Co. 358
Skinner Purifiers Div., Bendix Aviation Corp. 388
Soreng Mfg. Corp. 395
Southern Friction Materials Co. 432
Spincraft, Inc. 312
Sponge Rubber Products Co. 273
Square D Company, Milwaukee 46-47
Stackpole Carbon Co. 278
Stalwart Rubber Co. 249
Standard Pressed Steel Co. 227
Standard Products Co. 319
Standard-Toch Chemicals Inc. Standard Varnish Works Div. 84
Stewart Warner Corp. Alemite 65
Stokes Machine Co., F. J. 299
Streeter-Amet Company 315
Sunnen Products Co. 389
Superior Steel Corp. 365
Sweet's Catalog Service 324-325
Syntron Co. 415

Taco Heaters, Inc. 277
Taylor Fibre Co. 327
Telechron Dept. General Electric Co. 74
Tennessee Coal, Iron & Railroad Co. 16, 52
Thomas & Betts 40
Thomas Flexible Coupling Co. 268
Thomson Industries, Inc. 271
Tickle Engineering Works, Arthur 330
Timken-Detroit Axle Co., Brake Div. 14
Timken Roller Bearing Co. (Industrial) ..... 4th Cover
Timken Roller Bearing Co. (Steel & Tubes) 75
Tinnerman Products, Inc. 116
Tomkins-Johnson Co. 446

INDEX TO ADVERTISERS

Torrington Co. 268
Torrington Co. (Needle Bearings) 69
Townsend Co. 343
Trostel & Sons Co., Albert 246
Tuthill Pump Co. 438
Tuttle & Kift, Inc. 387
Twin Disc Clutch Co. 266
Tyer Rubber Co. 358

Union Carbide & Carbon Corp.
Bakelite Co. 10
Linde Air Products Co. 435
Union Chain & Mfg. Co. 344-345
United-Carr Fastener Corp. 229
United Electric Controls Co. 302
U. S. Electrical Motors, Inc. 401-402
U. S. Gasket Co. 459
U. S. Graphite Co. 12, 13, 36
U. S. Pipe & Foundry Co. (Special Products) 320-321
U. S. Rubber Co. (Mechanical Goods) 413
U. S. Steel Co. 16, 52, 66
U. S. Steel Export Co. 16, 52, 66
Universal Clay Products Co. 302
Universal Metal Hose Co. 358

Van Cleef Bros. Inc. 326
Van Huffel Tube Corp. 363
Veeder-Root Inc. 17
Vellumoid Co. 354
Vickers, Inc. 60
Viking Pump Co. 398
Vulcan Electric Co. 326

Wagner Electric Corp. 316-317
Waldes-Kohinoor, Inc. 37
Ward Leonard Electric Co. 254-255
Waterman Engineering Co. 318
Watertown Mfg. Co. 461
Westinghouse Electric Corp. 24-25, 70
Wheeler Insulated Wire Co. 276
White Dental Mfg. Co., S. S. 410
Whitney Chain Co. 50
Williams & Co., J. H. 418
Wilson Co., H. A. 338
Wirebound Box Mfgs. Assn. 253
Wisconsin Motor Corp. 240
Wolverine Tube Div., Calumet & Hecla Cons. Copper Co. 86
Westinghouse Electric Corp. 24-25, 70
Wrought Washer Mfg. Co. 282

Yale & Towne Mfg. Co. 411
Yoder Co. 103

Zenith Carburetor Div., Bendix Aviation Corp. 426

■

PROFESSIONAL SERVICES ... 452

■

SEARCHLIGHT SECTION
(Classified Advertising)

EMPLOYMENT
Positions Vacant 450-452
Positions Wanted 452
Employment Services 452
SPECIAL SERVICES
Contract Work 452
NOTICES
Legal 452

■

Advertisers' Index starts on 456
Product Index starts on ... 453

SIZE

...and the skill to use it wisely!

A new heavyweight in the Watertown production line that means . . . larger integral moldings, faster molding cycles, lower costs, flexibility of application and top volume output.

This new 64 oz. injection press is another in a long line of very good reasons for calling on Watertown when you're faced with the problem of selecting the right custom molder for that big, important job.

Take advantage of this more than efficient mating of trained, capable minds and a smooth functioning, versatile machine . . . a combination with the proven ability to deliver any type of large, one-piece housing, cabinet or panel requiring thermoplastic materials. Molding your part in one piece might well be the answer to the high cost of sub-assembly procedures.

At Watertown you'll always find the perfect production situation . . . constantly improving and expanding plant facilities, skillfully applied under experienced supervision.

If you have a particular part or product in mind, call on Watertown for the engineering facts and cost data. If your specifications are complete, drop a copy in the mail today for price quotation and delivery information. . . . No obligation, naturally.

WATERTOWN
MANUFACTURING COMPANY
300 ECHO LAKE ROAD
WATERTOWN, CONNECTICUT

SINCE 1915

COMPARISON PROVES the VALUE of VEELOS

the Adjustable V-Belt...

IF you specify v-belt drives for the machines you design you'll be interested in this clear statement of facts about VEELOS, the link v-belt, and endless v-belts.

These 4 reels of Veelos provide up to 316 standard v-belt sizes.

COMPARISON TABLE
VEELOS and ENDLESS V-BELTS

what about...	Veelos V-Belts	Endless V-Belts
ADJUSTABILITY	*Any* length can be provided for *any* v-belt drive due to link construction.	Standard or special lengths must be supplied for *individual* drives.
INVENTORY	MINIMUM INVENTORY. 4 reels can care for every v-belt need in the O, A, B and C widths. No deterioration or obsolescence of spare belts.	LARGE INVENTORY. 316 sizes are required to provide a *complete* stock in the O, A, B and C widths. Spare belts not immediately used will age and deteriorate.
STOCKROOM STORAGE	SMALL SPACE. It takes less than 2 square feet of wall or floor space to store 4 reels of easily identified Veelos.	LARGE SPACE. Walls and ceilings are often covered with stocks of endless v-belts. Identifying and maintaining full stocks is difficult and costly.
INSTALLATION	Installs quickly *on any drive* without resetting motor or tearing down outboard bearings.	Necessary to reset motor and tear down drives with outboard bearings.
MAINTENANCE	Belts can be adjusted or replaced without moving the motor.	Sliding or pivoted motor bases are necessary to replace endless v-belts. Belts cannot be adjusted individually.
OPERATING EFFICIENCY	Full power delivery can be maintained because the tension of each belt in a matched set is kept uniform by removing or adding links.	Individual belts cannot be adjusted to maintain uniform tension and provide full power delivery.
DRIVE LAYOUT	No limitations are imposed by belt length.	Limited by the availability of standard or special belt lengths.

If you would like to learn more about Veelos—how it can save you money and keep your machines producing—write today for your copy of the Veelos Data Book. It's free and full of facts!

VEELOS
THE LINK
V-BELT

MANHEIM MANUFACTURING & BELTING COMPANY
MANHEIM, PENNSYLVANIA

...ADJUSTABLE TO ANY LENGTH...ADAPTABLE TO ANY DRIVE

Made in all widths in three types: regular, oil-proof and static conducting. Also double V in A and B. Packaged on reels in 100-foot lengths. Sales engineers in principal cities; over 350 distributors throughout the country. VEELOS is known as VEELINK outside the United States.

STILL THE ALL-AMERICAN FIRST

Master Gearmotors have given more millions of hours of satisfactory service in the field than all other makes . . . COMBINED.

THE MASTER ELECTRIC COMPANY · DAYTON 1, OHIO

Production stamina, tool-room accuracy ..lathe gets both with TIMKEN® bearings

THIS "Economy" lathe is designed to fill a specific demand for a medium-priced lathe which has these two qualities: ruggedness for general production work and accuracy for tool-room service. To insure these two qualities, Rockford Machine Tool Co. mounts the spindle and gear shafts on Timken® tapered roller bearings.

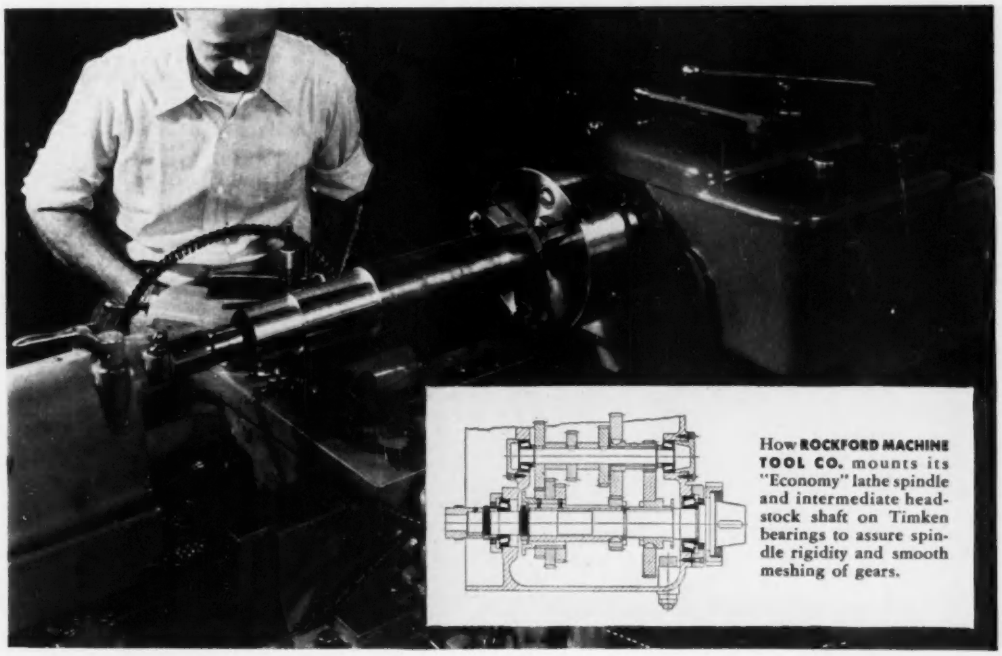
With Timken bearings, the spindle is held in rigid alignment. Precision is maintained. Gears mesh smoothly — with minimum wear even under the heaviest loads.

Because of their tapered construction, Timken bearings take radial and thrust loads in any combination. Line contact between rollers and races provides extra load-carrying capacity. The true rolling motion and incredibly smooth surface finish of Timken bearings practically eliminate friction.

Timken bearings hold shaft and housing concentric, making closures more effective. Because they are (1) precision manufactured, (2) engineered for the job, (3) made of Timken fine alloy steel, Timken bearings normally last the life of the machine.

When you buy or build machine tools, be sure they are equipped with Timken bearings. No other bearing can give you all the advantages of the Timken bearing. Look for the trade-mark "Timken". The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ont. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



How **ROCKFORD MACHINE TOOL CO.** mounts its "Economy" lathe spindle and intermediate headstock shaft on Timken bearings to assure spindle rigidity and smooth meshing of gears.

FINISHED TO CLOSER TOLERANCES

Finishing to incredible smoothness accounts for much of the precise, smooth rolling performance of Timken bearings. This honing operation is typical of the amazingly accurate manufacturing methods of the Timken Company.

The Timken Company is the acknowledged leader in: 1. advanced design; 2. precision manufacturing; 3. rigid quality control; 4. special analysis steels.

TIMKEN

TRADE-MARK REG. U.S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ⊂⊃ THE TIMKEN TAPERED ROLLER ⊂⊃ BEARING TAKES RADIAL ⊂⊃ AND THRUST ⊂⊃ LOADS OR ANY COMBINATION